NATURE

No. 4493 SATURDAY, DECEMBER 10, 1955 Vol. 176

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HIGHER TECHNOLOGICAL EDUCATION IN BRITAIN

ALTHOUGH in his inaugural address as rector of the Imperial College of Science and Technology on October 11, Dr. R. P. Linstead made no fresh statement as to the building plans for the College, he said enough about the future of the Imperial College to indicate the shape that this new development in higher technological education is likely to take. Some of the implications can now be seen fairly clearly, and it is important that they should be fully discussed, and appropriate measures taken elsewhere to counteract any possible weaknesses which this entirely new but desirable experiment in technological education may involve in the system of higher technological education in Britain. Dr. Linstead's address establishes beyond question that the expansion of the Imperial College is being planned to make its major contribution to the supply of technologists at the postgraduate level, and that it is doing so in ways for which there is no precedent in the universities of Britain or in institutions such as the Massachusetts Institute of Technology in the United States or elsewhere.

In his presidential address to the North-Western Branch of the Science Masters' Association a year ago, Dr. B. V. Bowden described the American institutes of technology as essentially universities, dealing in the main with practical subjects, with humanities as subsidiaries; and he added that one of their aims was to produce large numbers of cultured qualified men who at the same time are essentially practical rather than theoretical in outlook. That is a fair description of the type of men and women which the Imperial College hopes to produce in increasing numbers; but, as Dr. Linstead indicated, it is hoped to do so without including the humanities specifically in the curriculum.

Since some of the American institutes of technology require their students to spend 16–20 per cent of their time on the humanities, the expansion of the Imperial College to what may fairly be described as a technological university with some 3,000 students—with about 1,400 of them postgraduates—and an administrative and teaching staff of 1,500, comparable in size roughly with the Universities of Birmingham, Leeds or Liverpool, may be described as a new venture in respect both of structure and of curriculum. The scientist and technologist will have unfettered and unchallenged opportunity to demonstrate the capacity of their disciplines to develop men capable not only of clear thinking but also of a balanced outlook, and imaginatively alive to the human issues with which the technologist, no less than the manager and administrator, is confronted.

Dr. Linstead was re-assuring on two or three points. He does not think that the proposed expansion will be achieved at the expense of other universities or of the technical colleges. Although almost the whole of the undergraduate students of the College come from within the United Kingdom, it is probable that the additional intake of about one hundred freshmen a year will come from the impending bulge in the senior school population, quite apart from attention to such measures as have been suggested in the report on "Early Leaving" and elsewhere. Moreover, the extent to which postgraduate students are drawn from overseas suggests that the prospects of obtaining the greater numbers of students of high quality is reasonable enough, in spite of the misgivings which Sir Henry Tizard expressed in his Haldane Memorial Lecture. Further, as Dr. Linstead pointed out, a considerable proportion of the postgraduate students will come from posts in industry or government service, and from other universities and colleges.

Concentration of such advanced specialized technological training is clearly desirable from the national point of view, and Dr. Linstead indicated that the Imperial College recognizes its responsibility for choosing its regions of specialization wisely in relation to national needs and the provisions made elsewhere. He also forestalled criticism in his remarks as to the reduction of wastage. This occurs in all universities, though not always at the same stage. At the Imperial College it occurs mainly at the end of the first year, where it is obviously better to effect any necessary elimination rather than later. None the less, attention is being given to the further reduction of this wastage, some of which is certainly unavoidable if high standards are to be maintained.

On these and other points it must be some years after the end of the next quinquennium before any sound judgment can be formed as to the value of this experiment, or as to its full implications for the expansion or development of technological and technical education in Britain. Meanwhile, it should be recognized for what it is—a massive experiment in education that is in line with much that has been in progress elsewhere in the universities since the Second World War and of which the University College of North Staffordshire provides a striking example. It is also thoroughly in keeping with the British genius for improvization and experiment, to which we already owe important advances, and which incidentally provides one of the fundamental reasons why a system of education is not exportable.

Perhaps the feature of this expansion which will be watched with the closest interest is the success of the attempt to provide a broader education, and by novel methods to produce technologists and scientists of the highest professional competence who are also well-educated men and women competent, in Milton's phrase, "to perform justly, skilfully, and magnanimously all the offices both private and public of peace and war" that may fall to their lot. The interest will indeed be the keener in that here the Imperial College has not yet fully determined in detail the methods it means to use. Indeed, as Dr.

Linstead pointed out, some of the most important broadening influences cannot come into play on any adequate scale until the building plans have advanced.

Prominent among these are the plans to increase the residential accommodation from its present eight per cent to sixteen (about five hundred residents) and to provide a new Students' Union double the size of the old. This expansion is viewed as part of a deliberate attempt to encourage the broadening influence of informal discussion between students outside their formal studies, and to provide conditions in which the programmes of general studies and week-end discussions can most favourably take place. Dr. Linstead stressed the importance of all such efforts the more in that he recognized that there are strict limits to what can be attempted within the normal curricula. He also referred to the broadening influence of the great flood of London life as something unrivalled in more provincial environments.

While the possibility of such an extra-curricular education will be granted, Dr. Linstead may well be optimistic as to its probability, even under due guidance and encouragement. Some inquiry on this point might well be worth while. What he said as to keeping the range of studies natural and appropriate to the College as wide as possible, should also be noted. The full range of subjects appropriate to a university will not be achieved at South Kensington; but on the teaching and practice of the departments of pure science will largely depend the success of this attempt to provide, not narrow technologists, but educated men capable of vision and sound judgment. Unless those departments rise to the challenge and show that their disciplines can be taught with imagination and balance, the experiment will be in grave danger.

Clearly, much will depend on the extent to which the departments of pure science are kept strong and of the highest standard, and on the quality of the staff; though it is probably also true that in respect of some of the other broadening influences mentioned by Dr. Linstead the quality of the students will have some influence in determining their effectiveness. This is notably true in respect of life in London, which presupposes a certain stability of character if it is to be beneficial, and also no undue pressure of home influence or poverty. At best, in fact, while a modicum of hostels and a good Students' Union make the social life of the College warm, their broadening influence is random.

Nor is the mastery of and delight in the Queen's English, which Dr. Linstead also commends, to be achieved without systematic and deliberate effort. Particularly if it is to assist the graduate to carry away from such an institution an awareness of the richness and diversity of life and an appreciation of those things which adorn it, more is likely to depend on the teaching in the schools than on that given at the Imperial College in a curriculum from which non-scientific subjects are excluded. The Imperial College under such conditions can do little to further this end, except perhaps by developing as early as possible, and perhaps expanding, the experiment of an optional preliminary year to which Dr. Linstead referred. The non-scientists entering under such a scholarship scheme could well provide a very effective leaven under the conditions which increased residential facilities and the new Students' Union will provide.

An even more promising and less-random influence could be the teaching of the history of science and technology, a general knowledge of which would, as Dr. Linstead said, give a sense of perspective and balance, and show something of the way in which great minds have urged men forward. It is a little disappointing that Dr. Linstead did not give any evidence that the Imperial College proposes to experiment in this field, as has been done elsewhere in recent years. Cambridge scientists, for example, are almost unanimously in favour of teaching the history and philosophy of science, and under the History of Science Committee set up in 1947 three courses have been tried to spread such teaching. The proportion of scientists reading the history and philosophy of science is now about one in ten, and a diploma in the subject is at present under consideration and, alternatively, a proposal to make it a subject for Part II of the Natural Sciences Tripos or even a separate Tripos.

Another such experiment, in the more limited field of engineering history, at King's College, University of Durham, was described by Prof. A. F. Burstall at the summer meeting of the Newcomen Society last June. Here, however, the primary objectives were to teach the students to read critically and to encourage them to acquire sufficient broad factual knowledge of the history of technology to develop the breadth of vision claimed as characteristic of students of history. It was also desired to encourage them to work together, and in a measure to learn from one another in just the way in which Dr. Linstead visualizes the students at the Imperial College may acquire a broader outlook.

Whether or not the decision to extend the first-degree course from three years to four years is taken, a strong case can thus be argued for including the history of science and technology in the basic curriculum. Its exclusion could only be justified in the face of clear evidence that sustained and well-planned, rather than random, efforts are being made to encourage the development of a broad outlook and wide appreciation of cultural values and human achievement. Dr. Linstead and his colleagues should be alert to see that neither any promising experiment of this kind nor the scholarship experiment for non-scientists to which he referred is allowed to be hamstrung or limited by unreasonable examination requirements.

The study of English, however, has a further, but equally important, aspect for the student of science or technology on which Dr. Linstead did not touch, though it was the subject of a lively discussion last month before the Parliamentary and Scientific Committee, in which the Duke of Edinburgh took part.

Mastery of the English language is desirable from the point of view of the communication of ideas, quite as much as from that of encouraging a science of perspective and balance. Whatever point of view

we take with regard to the interpretation of science, whether we lay the onus on the scientist for expressing himself in terms and in ways that the layman can understand, or whether, like the Duke of Edinburgh and Sir Henry Tizard, we look rather to the improvement of the scientific education of the layman, without a reasonable mastery of English the scientist is unlikely to be able to communicate fully even with those in other scientific fields. It is not simply a matter of avoiding unreasonable demands on the scientist to express himself in non-technical language; unless his choice of technical terms is restrained by the sense of perspective and balance which an adequate knowledge of his mother-tongue confers, no improvement in the technical and scientific knowledge of the ordinary citizen will avoid confusion and misunderstanding. Mr. Ritchie Calder has quite rightly insisted that the communication of knowledge and ideas depends fundamentally on the careful and skilful handling of words, and this is as true of the scientific or technical paper as of popular exposition.

The success of this experiment at the Imperial College of Science and Technology will really depend on two things: first, whether the College can secure and maintain a teaching staff of the requisite standard and breadth of vision, capable, within the limits set by the scientific and technological disciplines to be taught, of inspiring their students with that same breadth of vision and understanding, no less than with the capacity for clear and critical thinking. Secondly, it will depend no less on a continuing entry of students of sufficient capacity. Any relaxation of standards in either respect—in the recruitment of staff, or the selection and elimination of students—would be fatal. For that reason alone, the progress of the experiment should be closely watched, and particularly carefully by the University Grants Committee and the Parliamentary and Scientific Committee. For although the recent broadsheet on "Graduates' Jobs" issued by Political and Economic Planning is only a preliminary survey, it gives at least a hint, which is supported elsewhere, that there is a strict limit to the number of students qualified to profit by courses such as an institution of the standard of the Imperial College provides. Part of the solution to Britain's problem of scientific and technical manpower lies in the wiser and more efficient use of the limited supply of really first-class minds.

PURPOSE IN EDUCATION

Education and the Modern Mind

By Prof. W. R. Niblett. Pp. 155. (London: Faber and Faber, Ltd., 1954.) 8*s*. 6*d*. net.

MANY books are published dealing with educational topics; surprisingly few are written about education itself. Prof. W. R. Niblett has attempted to do this, and by all except the confirmed materialist, his book will be welcomed both for its inspirational qualities and for its practical suggestions on means of achieving ends which are admittedly difficult to attain.

Throughout the book Prof. Niblett emphasizes that it is no good considering the purpose of education without discussing the purpose of living itself; it is impossible to evolve a satisfactory philosophy of education without having evolved a satisfactory philosophy for life. Unfortunately, so many people in the Western world assume that the reason for existence is to 'get on' and be 'happy'. This superficial attitude to life has bitten deep in many people and seems to be an accompaniment to the mentality associated with the Welfare State.

Prof. Niblett questions whether the acquisitive attitude can provide a satisfactory philosophy of life, since it leaves out a whole dimension of human experience; it is very doubtful whether it leads to 'happiness'. Much of the so-called 'happiness' to-day is there only when there is something 'going on'; too often this is succeeded by a vacuum of despair when people come face to face with themselves.

There are signs, however, that the determination to 'get on' is failing to satisfy and that the possession of material resources may be temporarily satisfying but fail to satisfy those fundamental requirements of man which are of an intangible nature. As a result, a new challenge is being presented to all who help to educate the young. Some educationists respond to this challenge by seeking to increase the number of schools and laboratories and community centres. Others, and Prof. Niblett is one, believe that these things are desirable only if they are used to extend and strengthen fundamental values and that much more could be done with existing facilities.

Fundamental values, he says, have been weakened by two main causes—one minor and one major: the minor cause is two World Wars; the major, the spread of the scientific temper of mind. As an instrument of analysis, the latter is indispensable, and there is need for its wider extension throughout the world if, as is desirable, more and more people are to benefit from material progress. Yet extension carries certain dangers. The application of scientific disciplines like psychology and sociology to problems of man himself leads many to believe that all man's experience is amenable to detached analysis. At this point Prof. Niblett stands firm and, in words of rare poignancy, argues with conviction that there is much in human experience which no known methods of analysis can explore. There are different kinds of facts, different kinds of knowledge, and different kinds of human experience. Some of these can be acquired by direct 'education'; some by providing the right kind of environment, inside or outside the schools. Others can only be arrived at by living itself and by the transmission of standards and values from one person and one group to others.

In the latter part of his book Prof. Niblett suggests ways in which educational institutions can effectively pass on the basic requirements for living like the three 'r's' as well as the basic requirements for life like analytic detachment, humour, humility, responsibility, sympathy, unselfishness and courage. Here some educationists will quarrel with his choice of subjects and the suggested methods of treatment. Few will withhold their respect for views which bear the hall-mark of original thought and which do not regard long-established curricula as sacrosanct or immutable. With many children, for example, Prof. Niblett thinks that much time is wasted in trying to teach them arithmetic despite years of failure; why, for such children, should it not be dropped at, say, fourteen years of age? Much valuable time could

also be saved if a bolder policy of omission were carried out in all kinds of schools with foreign languages and subjects like drawing and woodwork.

Many sixth-form science teachers will feel that Prof. Niblett's strictures on the teaching of science in grammar schools are a little harsh. Yet most will agree that there is the ever-present danger that, to many sixth-form boys, "his science, instead of being a discipline, becomes an end, itself degenerated to a technique, a know-how of getting through examinations and later a know-how of technical progresses, and not the beginnings of a philosophy". Science can, and should, be taught to nourish the imagination and to add to the power to generalize. With teachers who possess both a philosophy of science and a wide scientific knowledge, it is not too difficult for students to catch the meaning and method of scientific inquiry and the humility which goes with it.

The final chapter is concerned with the release of leadership. The value of tradition in the life of the school is well brought out—as is the difficulty of building one in many secondary modern schools which are too tightly controlled by local education authorities. If ground is to be prepared, however, in which leaders may grow, there must be a constant succession of teachers of high quality—men and women whose own lives reflect the most worthy characteristics of a good society. Does our society want such a flow of teachers? What status have they in the community? What salaries are they paid? How many teachers are asked to serve on representative national committees—even committees upon education itself? How many teachers ever appear in New Year or Birthday Honours lists?

These are questions which a good society would be able to answer in a way that would recognize the importance of the teaching profession at all levels to the community as a whole. They have been sharply pointed by an author who has thought deep and writes with such skill and lucidity that his book deserves to become as well known as Sir Richard Livingstone's "The Future in Education".

T. H. Hawkins

TEXT-BOOKS OF NUCLEAR PHYSICS

Nuclear Physics

By Dr. Irving Kaplan. (Addison-Wesley Series in Nuclear Science and Engineering.) Pp. xi+609. (Cambridge, Mass.: Addison-Wesley Publishing Company, Inc., 1955.) 10 dollars.

Nuclear Physics

By Prof. Alex E. S. Green. (International Series in Pure and Applied Physics.) Pp. xv+535. (London: McGraw-Hill Publishing Company, Ltd., 1955.) 64*s*. 6*d*.

In the first of these two books under review, Dr. Irving Kaplan requires no more of his reader than "a two year course in college physics and a familiarity with integral and differential calculus". From such small beginnings he has produced a thoroughly readable and clear account of most features of 'pure' nuclear physics, and found room for such items of 'nuclear technology' as the design of accelerators, nuclear reactors and isotope separation.

In the first quarter of the book the nucleus is approached no more closely than Rutherford's early researches on α-particle scattering allowed. The starting-point is the earliest chemical evidence for an atomic theory and a periodic table of elements. The classical experiments on cathode and 'canal-rays' are described next, and the discovery of radioactivity and elementary methods of radiation detection follow. Particularly well treated is the derivation of the Rutherford scattering law and its verification, in which the original experimental results confirming the predicted dependence on the element, the α-particle energy, the angle of scattering and foil thickness are tabulated. An account of Moseley's work on X-rays is followed by chapters on the quantum theory of radiation, the special theory of relativity and the Compton effect, and the hydrogen spectrum and its interpretation with the Bohr model. The hybrid nature of this model receives proper emphasis; the introduction of wave mechanics completes the first part. A plausible derivation of Schrödinger's equation is included, without any examples of its solution; the interpretation of the periodic table in terms of the electron configuration and the operation of the Pauli exclusion principle are particularly clear.

The second part of the book, approximately one-half of the total, is concerned with the nucleus proper. The difficulties of the 'electron proton' model for the nucleus and its replacement by the 'neutron proton' model, the magnetic and electric moments, statistics and parity are dealt with first. The accurate determination of nuclear masses is described; but the interpretation is left to later chapters. Chapters follow on the laws of radioactive decay, with tables of the natural radioactive series, on the types of nuclear disintegration which may be produced by accelerated particles, on artificial radioactivity and on the details of the interactions with matter and the spectra of α-, β- and γ-radiations. At this point, there is a return to nuclear reactions, the discussion concentrating on the nuclear physics, rather than nuclear chemistry as earlier. The approach is descriptive throughout, and the experimental methods, results and interpretations are kept closely together. The classification of reactions follows that of Blatt and Weisskopf; reactions in the lighter nuclei are dealt with in a separate section and the emphasis in this field on the details of nuclear energy-levels, rather than the reaction mechanisms, is well brought out. The second part of the book closes with a chapter on nuclear forces and nuclear structure. The summary of results on the interaction of two nucleons is perhaps condensed too much, but the evidence for the magic numbers is well set out. The descriptions of the shell model, and Bohr's collective model, are very short indeed, and there is no account of the 'cloudy crystal ball'.

The third part of the book, approximately one-quarter, deals with special topics and applications. 'Neutron physics' is concerned mainly with the detection of neutrons, diffusion and slowing down, and the measurement of the various cross-sections in different energy regions, with little interpretation of results. The remaining chapters are devoted to fission, nuclear reactors, accelerators and isotope separation.

The main general impression is that the book is extremely readable. The line of development is neither strictly historical, nor by subject-matter (certain topics are discussed several times in widely separated sections), but is always clear. All relevant major review articles together with many references

to the literature are listed at the end of each chapter. A list of problems is also given; these are elementary and do not require access to material outside the book. Illustrations are excellent and copious, and a large chart of nuclides is included.

The book will be ideal for those whose work in neighbouring fields (reactor engineering and radiochemistry, for example) brings them in close contact with nuclear physics, and for many physics students. For undergraduates intending to specialize in this field and research students the book will be valuable, but a greater theoretical background will have to be sought elsewhere. No serious inaccuracies were noted. The text and diagram illustrating the energy-levels of the hydrogen atom are in disagreement; the remark that a smaller magnet is required in a linear accelerator than in a circular machine producing particles of the same energy is either self-evident or too subtle for the general reader.

The second book, by Prof. A. E. S. Green, also commences with a review of atomic physics. This is extremely compressed and requires that the reader know the field well beforehand. The next chapter enumerates the static properties of nuclei—the radii, masses and moments—and includes a long section on the classical interactions of the various moments with a field. The next three chapters are devoted entirely to technology and deal with accelerators, 'precision instruments' and detectors. It appears that much of the material contained herein would have been better placed in an appendix; an extremely complicated drawing of a β-ray spectrometer, circuit diagrams of amplifiers and multichannel pulse-height analysers, and a diagram illustrating how to read the interpolating lights of a scale-of-eight counter do not seem appropriate at this stage. More general ideas on how the various instruments are used for elucidating decay schemes or reaction constants are not put forward adequately. Chapters follow on radioactivity and nuclear reactions. The latter includes a detailed discussion on the absorption of γ-radiation and a complete treatment of the classical mechanics of reactions and the transformation between laboratory and centre of mass co-ordinates. The next chapter, on systematics and tendencies of nuclei, is a very thorough investigation of the nuclear energy surface as a function of atomic and mass numbers (and even–odd properties) and includes a discussion of the irregularities at the magic numbers. In the following chapter the liquid drop model is presented, and the interpretation and best values of the parameters in a semi-empirical mass formula are discussed at length; the chapter ends with a discussion of fission and the achievement of a chain reaction. The chapter on quantum mechanics and the nucleus is an excellent presentation of the Schrödinger equation; a variety of applications follows—to single bodies in various wells and to two- and many-body problems. The discussion includes the time-dependent wave equation, perturbation theory and the coupling of angular momenta. The next chapter discusses various nuclear models in fair detail, mainly in relation to ground-state properties. That on nuclear decay covers γ-, β- and α-ray decay theory concisely and clearly. The formal theory of reaction processes is developed next, and this is perhaps the most valuable chapter in the book, which closes with an analysis of what is known of nuclear forces from the low-energy nucleon–nucleon interactions and the properties of the deuteron, the difficulties raised by high-energy results, and a brief excursion into meson field theory.

Reference lists are given with each chapter, together with problems graded in difficulty, some requiring extensive reference to the current literature.

The book is in many ways complementary to that by Dr. Kaplan. A previous study of the latter will help overcome the difficulties arising from the rather complete separation of techniques, results and interpretation made by Prof. Green. His book, on the other hand, though requiring more from the student and covering less ground, is able to provide the necessary discussion of the more difficult topics treated in a purely descriptive fashion by Dr. Kaplan. A few errors have been noted. The very brief description of deuteron stripping suffers from confusion between the appearance of groups of product particles of discrete energies and resonance in the reaction yield. In the discussion of neutron-detection techniques, the use of a chamber filled with boron trifluoride is described, and the statement is made that "these chambers may be used as proportional counters in the low-energy region, since the reaction yield for a fixed neutron flux depends sensitively on the neutron energy". This is a novel and unhelpful usage of the term "proportional counter". The derivation of the reciprocity theorem needs more explanation, and spin factors might well have been included.

R. C. Hanna

ELECTRICITY FOR THE UNINITIATED

A Guidebook to Electricity

By J. H. M. Sykes. Pp. 275+16 plates. (London: Hutchinson's Scientific and Technical Publications, 1955.) 21*s.* net.

WRITERS of popular science books might well study the handicapping system used in golf. The real expert does not moderate his accuracy to suit the competence of his companion; instead, an approximate adjustment to equal terms is made on a quantitative rather than a qualitative basis, and the full rigour of the game is enforced. If similar measures had been taken by the author of this well-illustrated and informative book, by simply omitting paragraphs here and there, one could recommend it without reservation or criticism.

The descriptions of electrical machines, wiring systems, domestic appliances and communications devices are good, and the technical side is well presented in an interesting manner. Alternating current in general, and three-phase systems in particular, are discussed very clearly in non-mathematical terms; and there are a glossary and some useful tables at the end. The general reader for whom it is primarily intended will gain from it a good idea of the way in which most of the applications of electricity in everyday life work. This, according to the preface, is the limit of the author's aim, and in this he has succeeded.

Bearing this deliberate limitation in mind, any criticism of the references to fundamental principles may seem unfair. But it is one thing to avoid delicate discussion of the facts of life, and quite a different matter to describe stork-legends seriously and in circumstantial detail. That the liberation of an electron from a copper atom "could only be undertaken if enormous force is available, such as the power necessary when nuclear fission is carried out", and that "the speed with which electrons fly round

their orbits in each atom is related to the temperature —if the temperature is greatly increased they begin to fly round so rapidly that eventually one of them flies off altogether by a kind of centrifugal force" are statements in a class by themselves. The introduction to radio as the propagation of "electromagnetic and electrostatic" waves by a process of electrostatic induction is unfortunately plausible. The old international ohm is defined as a piece of platinum preserved somewhere, and even the statement of Ohm's law would not be accepted in an Ordinary-level physics examination. The unwritten law (which should be restricted to the same category of book) requiring a certain tempering of the scientific usage of the terms force, work, and power for the layman, so that they are used correctly in some places and interchangeably in others, has been operative here.

The pity is that blemishes of this kind in an attractive and otherwise excellent book should, because they are barely relevant to its main message to the general reader, appear to be trivial. They greatly reduce its value for the student to whom it is also directed, for he cannot afford to take that point of view. In guide-book terms, this does the tourist handsomely and treats the fell-walker pretty well; but it is not for those who also want a little serious climbing.

G. R. Noakes

PROBLEMS OF TECHNICAL LIBRARY SERVICES IN GREAT BRITAIN

Commercial and Technical Libraries

By J. P. Lamb. (The Library Association Series of Library Manuals—10.) Pp. 316+7 plates. (London: George Allen and Unwin, Ltd., and the Library Association, 1955.) 21*s*. net.

THE Sheffield City Librarian, Mr. J. P. Lamb, has long been known outside the circle of public librarians for his part in the highly successful interchange scheme for technical publications which he first described to an Aslib Conference more than twenty years ago. This latest book of his is addressed primarily to those concerned with the running of a public commercial and technical library. While, however, his chapters on the equipment and staffing of such a library, the principles which should determine its relation to the public library system generally or the selection of its stock, whether of books and periodicals or of patent specifications, are chiefly of interest to those engaged in such work, the imagination and shrewd common sense which have contributed so much to the success of the Sheffield scheme continually break through and give his chapters a wider interest or relevance. Always he is impatient of operational ineptitude or of grandiose schemes which have little relation to reality, whether it be for book coverage or anything else. He is keenly alive to the fact that libraries are for use, and this pervading sense of users' needs makes such a chapter as that on organization and administration as interesting to the general reader as to the librarian.

To the technical librarian in industry these chapters are almost as useful and suggestive as they are to the librarian engaged in public library service, and parts of them will interest the technologist and scientist. To such, and perhaps to the industrialist generally, the chapter on external activities will be of no less interest, and many will be surprised at the scope and extent of the activities of the technical information departments which are already maintained by some public libraries. Mr. Lamb's account is the more welcome in that, as he duly points out, an inquiry in this field made by the Federation of British Industries, in collaboration with the Panel on Technical Information Services of the Committee on Industrial Productivity, largely overlooked what was being done by the public libraries and gave no indication of the extent to which such activities enable commercial and industrial concerns to economize in the information services they themselves maintain.

In Great Britain the smaller firms especially are as yet barely conscious of the needs which the public commercial or technical library could thus meet, and Mr. Lamb is rightly critical of this omission in an important report, the paragraphs of which relating specifically to public libraries he quotes in full in his final chapter. It is this chapter and that in which he reviews briefly the history of British commercial and technical libraries and notes some of the missed opportunities of the inter-war years that are of most interest to the general reader as well as to the scientist. To the latter this concluding chapter, with its admirably balanced survey of the future in which proposals, for example, for a science centre, including a national lending library of science and technology as well as a national reference library for that field, are placed in their proper perspective in relation to the existing library resources of Britain, including those of the public library system, is absorbing.

This chapter, which displays clearly the bearing of an efficient technical library system on technical education, industrial research and industrial efficiency in general, is of particular interest at the moment in that, since this book was written, the Advisory Council on Scientific Policy, in its eighth annual report, reverts again to the place of scientific libraries in the national economy, both in securing the most effective use of the nation's scientific and technical man-power and in furthering the dissemination of technical information as well as the development of higher technological education. In this respect Mr. Lamb's account needs amplifying, for as it stands it suggests that the Advisory Council has dropped its support for the project of a national lending library. For all that, his chapter admirably states the case for a national lending library and a national reference library and for the way in which both could be supported by existing public technical library services. It gives a concise but clear picture of the advantages and economy to be derived from a carefully thought-out policy of utilizing to the full existing services, but providing at the centre the essential national services to which the Advisory Council on Scientific Policy points.

The limitations of interchange schemes are clearly recognized; but none the less, Mr. Lamb puts clearly and fairly both the advantages of such schemes in relieving pressure on a national lending library of science and technology and the case for a government grant to those public technical libraries which, by co-operating in this and other ways with the national lending reference library, would increase its efficiency and resources and secure a better use of the nation's existing resources and services, whether in the way of books and periodicals or of trained staff.

R. Brightman

British Journal of Applied Physics
Edited by Dr. H. R. Lang. Vol. 5, 1954, and Supplement No. 3: The Physics of Particle Size Analysis—a Conference arranged by the Institute of Physics and held in the University of Nottingham from the 6 to 9 April, 1954. Pp. vi+466+supplement 218. (London: Institute of Physics, 1954.) £5 14*s.* 6*d.*

IN its annual report to the board of the Institute of Physics, the advisory committee of the *British Journal of Applied Physics* recently commented on the satisfactory increased circulation and high standard of the *Journal*, and this is amply justified by Vol. 5 which covers 1954. The volume contains twelve special articles, three conference reports and seventy-nine original contributions, in addition to a lengthy supplement of 218 pages.

Most of the special articles consist of lectures delivered by their authors to various branch and group meetings of the Institute. R. W. G. Wyckoff writes on the growth of X-ray diffraction work in the United States—the subject of his evening discourse to the X-ray Analysis Group on November 20, 1953; W. A. Wooster on diffuse X-ray scattering and the physical properties of crystals; O. R. Frisch on the beginnings of atomic energy, and R. Fürth on statistical concepts in theoretical physics, both lectures to the Education Group; V. Daniel on the thermodynamic approach to solid structure; and others on such varied topics as supersonic gas flow, the electrical breakdown of gases, the junction transistor, and the near infra-red absorption spectra of fibres. In the three conference reports, the proceedings are summarized of the conferences on X-ray analysis held in London during November 1953 and in Cambridge during April 1954, and on electron microscopy in London during November 1953.

The secretary of the Institute of Physics and editor of the Institute's journals, Dr. H. R. Lang, contributes the editorial note to the supplement, which is a record of the proceedings of the conference on the physics of the analysis of particle size, arranged by the Institute and held at the University of Nottingham during April 6–9, 1954. Forty-two papers were presented, and these, together with the discussions on them, are grouped in eight sections corresponding to the eight sessions into which the conference was divided. It is sufficient recommendation to quote from Sir Geoffrey Taylor's opening remarks that new and valuable contributions to the scientific study of the processes of particle separation are to be found in all the papers presented to the conference.

Geology in Engineering

By Dr. John R. Schultz and Dr. Arthur B. Cleaves. With a Chapter on Soil Mechanics by E. J. Yoder. Pp. ix+592. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1955.) 70*s.* net.

THIS well-planned and well-written book deals with the application of geology to civil engineering. It is more than a text-book of geology for engineers, since it discusses geology in such a way that engineers, on one hand, can appreciate when and to what extent they may expect the geologist to help them, and the geologist, on the other, may appreciate the problems with which the engineer has to deal.

The book is concerned with principles rather than case-histories, because it is the authors' opinion that the engineer will employ the geologist more for the inferences he will make than for his factual knowledge. Attention is directed to the necessity for the geologist to know what the engineer is aiming at in order that he may give the right information in the most useful form, while the engineer, on his part, must be able to appreciate the significance of what the geologist tells him.

The book is divided into twenty-two chapters, of which two-thirds deal with those geological processes and phenomena that have special application in engineering projects and difficulties, and the remainder with specific topics such as dams, reservoirs, roads and tunnels, and with recent developments in the field of soil mechanics and the uses of aerial photography in interpreting soil distribution and recognizing geological structures.

The reproduction of the half-tone illustrations which are distributed through the text leaves much to be desired; but there are many excellent text-figures, a useful bibliography at the end of each chapter, and an adequate index. F. J. NORTH

The Golden Eagle

King of Birds. By Seton Gordon. Pp. ix+246+16 plates. (London: William Collins, Sons and Co., Ltd., 1955.) 16*s.* net.

MR. SETON GORDON has lived all his life in the Scottish Highlands, has had exceptional opportunities of watching eagles, and has made good use of them. Not only has he kept nests under daily observation from the laying of eggs to first flight of the young, but he has also watched the adults hunting in mid-winter when the hills are covered with snow, and later seen them pair and build the nest. The results of all these observations are presented in a very readable form and include a number of new facts. No attempt is made to estimate the number of breeding pairs of golden eagles; but it may be said that during the past twenty-five years the numbers have been more or less stationary—a decrease in one part of the country and an increase in another. It is interesting to learn that birds have returned to their old haunts in the wilds of Galloway and Carrick and northern Ireland. A chapter is devoted to the use of the eagle in falconry, and we learn that in central Asia birds are used for hunting wolves, foxes and gazelle.

With the advent of sheep farming, and grouse shooting becoming a source of income to Highland lairds, the eagle would have been doomed if it were not for the enlightened policy of some landowners. That the eagle does take lambs at times there is ample evidence, and Mr. Seton Gordon himself has seen one carrying off a lamb. Nevertheless, he considers that "In Scotland the number of lamb-killing eagles is small—less than five percent". He goes on to say that lambs are not a regular prey of eagles in Scotland any more than man is of a tiger. Blue hares and rabbits are the principal food, and one wonders what they will turn to now that the latter have become so scarce.

The eagle's prey is varied and includes various mammals, grouse, geese and other birds. Though a number of grouse are taken, the author does not think they are destroyed in sufficient numbers to affect the stock on a moor; on the other hand, eagles kill grey crows, and it would be interesting to know whether the crow or the eagle has the greatest effect on the grouse population. A number of beautiful photographs adds much to the value of this interesting book. N. KINNEAR

Mr. H. N. RIDLEY'S HUNDREDTH BIRTHDAY

By J. W. PURSEGLOVE
Director of the Botanic Gardens, Singapore

DECEMBER 10, 1955, marks the hundredth birthday anniversary of Mr. Henry Nicholas Ridley, C.M.G., F.R.S. He was director of the Singapore Botanic Gardens during 1888–1912, and he will always be remembered in South-East Asia for his vital role in the foundation of the rubber industry and for his gargantuan contribution to our knowledge of the natural history of the area.

While still at school at Haileybury, he decided to devote his life to the study of natural history in the tropics. After graduation at Exeter College, Oxford, he was awarded the Burdett-Coutts Geological Scholarship. In 1880 he was appointed to the staff of the Botany Department of the British Museum in charge of monocotyledons, where he worked until 1887. During this period he became acquainted with many tropical plants and published papers on them. In 1887 he explored the island of Fernando de Noronha, Brazil, and later published accounts of its flora, fauna and geology.

Thus when Ridley arrived in Singapore in November 1888 as the first scientific director of gardens and forests, Straits Settlements, he was well qualified for the tasks which lay ahead. The Singapore Botanic Gardens had been founded on their present site in 1859, although there had been an earlier garden started by Raffles in 1822. Ridley's capability as a research worker and his work on economic crops and tropical botany succeeded in a surprisingly short time in pushing the Singapore Gardens to the fore as a centre of this work.

In the Economic Gardens, now the site of the University of Malaya, he found a plantation of *Hevea* rubber trees, produced from seedlings sent out by Sir Joseph Hooker from Kew in 1877, where they had been grown from seeds collected in Brazil by Mr. H. A. (later Sir Henry) Wickham. The seeds had not been smuggled out of Brazil as is often suggested, but had been obtained by the goodwill and co-operation of the Brazilian Government. Ridley at once began his famous tapping experiments, in which he demonstrated that the trees could be tapped regularly. Recently he told me that when he began he had no idea that rubber would be "a permanently milking tree". This work, together with his experiments on the preparation of rubber and his constant advocacy of it as a plantation crop, often in the face of opposition, led to the foundation of the present industry upon which so large a share of the wealth of Malaya and the eastern tropics has rested. Ridley remained in Malaya long enough to see the fruition of his labour and the great rubber boom of 1910. O. D. Gallagher, in an article in *The Observer* of June 25, 1955, writes: "He is one of the hundred or so men, out of the 2,500 million alive to-day, whose personal efforts have helped decisively to shape our modern life. His rewards have been meagre and mainly abstract. . . . Ridley's name is indelibly rubber-stamped in history."

Ridley's work on economic crops was not confined to rubber; he carried out experiments with most of the actual and potential tropical crops known. He provided not only local planters, but also all other tropical parts of the Empire and elsewhere, with planting material of rubber and many other crops. Visitors from all over the world came to see his experimental and demonstration plots. As early as 1889 he reported that cocoa would probably be profitable on the better Malayan soils, while in 1907 he directed attention to the possibility of oil palm as a plantation crop. Ridley produced the first written works of their kind on Malayan timbers, rattans and other forest products, as well as drug plants, fruits and spices. It should be realized that until the formation of the Agricultural Department in Malaya in 1904, Ridley and his three assistants at Singapore, Malacca and Penang were the only trained men to whom the planting community could apply for technical advice and help. Ridley studied in some detail the pests and diseases of the economic crops of the area, and specimens were often submitted to him by the planters for identification with requests for advice on their control. In 1891 he founded the *Agricultural Bulletin*, so that he could supply the planting community and others with information resulting from his many investigations. He continued to edit it until his retirement in 1912, and from 1900 it was published monthly.

"Mr. Ridley's work as a field botanist added more than that of any other single man to our knowledge of the flora of the Malay Pensinsula; his *Flora* (1922–25) is the foundation upon which all future work must rest." He was an indefatigable collector and a tireless worker. He made excursions to most parts of Malaya, often remote, as well as visiting Cocos and Christmas Islands, Borneo, Java and Sumatra. In all, he collected many thousands of specimens, of which a large number were then unknown to science. He named for the first time a few thousand plants, and a surprising number of Malayan plants are still only known from his original gatherings. Nor did he confine himself to plants, of which he collected all groups, but he also collected many animals as well, mainly vertebrates (excluding fish) and insects. Many plants and animals were named in his honour, including a New Guinea genus of orchids *Ridleyella* and a moth genus *Ridleyana*. It was Ridley who discovered that the ant *Oecophylla smarangdina* uses its own larvæ to make silk for the construction and repairing of its nest. Ridley added very considerably to the collection of cultivated plants, both Malayan and exotic, in the Botanic Gardens, Singapore, and brought back living plants from many of his excursions for growing here. He sent seeds of the more spectacular plants to Kew, where they were flowered for the first time in Europe. Hand-coloured illustrations and descriptions of some of these were published in *Curtis's Botanical Magazine*, of which Vol. 132 (1906) was dedicated to Mr. Ridley.

His first scientific paper was published while he was still at school, and in all he published more than five hundred papers, articles and books, amounting to some ten thousand printed pages, dealing with tropical agriculture, botany, zoology and geology. A full list of his publications up to 1935 is given in the *Gardens' Bulletin* (9), which was dedicated to him

on his eightieth birthday. His encyclopædic volume, "The Dispersal of Plants throughout the World", embodying many original observations, was published in 1930 when he was seventy-five. Commenting on his published work, one critic has said: "That there were inaccuracies goes without saying, but it was just that quality of recklessness in Ridley's work that enabled him to turn out such vast quantities of assimilable knowledge when it was most needed. A lesser man would have feared for his professional reputation, but Ridley was above such petty considerations. The work needed doing, and with the means at his disposal he did it magnificently".

Mr. Ridley was secretary of the Royal Asiatic Society, Straits Branch, during 1889–1911, and editor of its journal, in which he published many original papers. In 1905 he gave the first course of botany lectures to the newly formed King Edward VII College of Medicine, now the Medical School at the University of Malaya, and continued these lectures until 1910.

Mr. Ridley was elected a Fellow of the Linnean Society in 1881 and of the Royal Society in 1907. His services were recognized by the honour of a C.M.G. in 1911. His work as a naturalist and in establishing the Para rubber industry has been recognized officially by various scientific and industrial bodies. We are planning appropriate celebrations at the Botanic Gardens, Singapore, on his hundredth birthday, which will include an exhibition of "Ridleyana".

It is my fervent hope that the Singapore Botanic Gardens may long continue as a leading centre of research in tropical botany and a worthy memorial to Mr. Ridley and all that he has done for us during his long and productive life. I am sure that readers of *Nature* will join with me in congratulating Mr. Ridley on the present happy occasion of his centenary and in wishing him "Many Happy Returns".

THE ROYAL SOCIETY

ANNIVERSARY ADDRESS* BY LORD ADRIAN, O.M., P.R.S.

AWARD OF MEDALS, 1955

Copley Medal: Sir Ronald Fisher, F.R.S.

THE rise of quantitative biology, which has been so noteworthy a feature of this century and especially of the past thirty years or so, has been due above all to the work of R. A. Fisher. The variability of living things posed problems and raised difficulties in the interpretation of experimental and observational data which made necessary something beyond the methods of the physical sciences. They required in fact a new approach to inductive inference, and one which would provide means of drawing conclusions of assessable reliability from variable material often available only in small samples. It is to Fisher's combination of mathematical skill and biological insight that we owe the developments, both theoretical and practical, which have done so much towards solving this problem and so making biologists of virtually every kind quantitative in their experiment, their analysis, and, most important of all, their thought.

Faced with the agronomical problems of Rothamsted, the staff of which he joined in 1919, Fisher began the remarkable series of statistical investigations which gave us the techniques described in "Statistical Methods", the tabular matter of "Statistical Tables" (published with F. Yates) for facilitating their use, and the philosophy of "Design of Experiments" by which they may be understood, appreciated and extended. The outcome has not merely stood the test of time in those branches of biology with which Fisher was immediately concerned, but also has had an ever-widening influence which now extends even beyond the borders of biology itself. In building the new biometry, Fisher has given especially to the younger biologists a confidence and quantitative outlook the full effect of which we have still to see.

While Fisher will always be associated chiefly with these developments in statistics and biometry, it should not be forgotten that he has made outstanding contributions in the field of genetics and evolution. He set us on the way towards the modern study of biometrical genetics, and his mathematical treatment of natural selection has provided the basis for much of our present studies of populations. His theory of the evolution of dominance introduced us to the notion of the modification by selection of gene expression, and we owe primarily to him the theory by which we came to understand the working of the *Rhesus* blood groups. He has indeed long been established internationally as well as nationally as one of our leading geneticists, than whom few have done more to further the understanding of evolutionary processes.

Royal Medal (A): Sir Alexander Todd, F.R.S.

Over a wide field, Todd has made distinguished original contributions to the chemistry of natural products, more particularly in the field of compounds of physiological importance. His remarkable contributions to knowledge and his brilliance as an investigator have been recognized internationally by both organic chemists and biologists.

Todd joined Sir Robert Robinson in 1931 and played an important part in investigations on the synthesis of anthocyanins. His earlier work included major contributions in the field of vitamin chemistry, for example, in relation to the development of the structure of vitamin B_1, and to its synthesis. Independent of Karrer and Fernholz, Todd established the structure of vitamin E and achieved a synthesis. More recently, he has turned his attention to the vitamin B_{12} group, and his degradative and synthetical

* Delivered at the Royal Society on November 30.

studies have recently made fundamental contributions to our knowledge of the nature of these substances.

Undoubtedly Todd's most outstanding work in organic and biochemistry is in the nucleic acid field. *Inter alia*, he has developed rational methods for the synthesis of natural purine and pyrimidine nucleotides and for their phosphorylation to the nucleosides, including a synthesis of adenosine diphosphate and adenosine triphosphate. These results, among many others, have been achieved by a combination of theoretical knowledge and great experimental skill, aided by modern techniques.

Todd has been a pioneer in the chemistry of cannabinol, a series of complex *bis-iso*quinoline alkaloids, insect pigments (especially the colouring matter of Aphidae), kousso, and natural tropolones of mould origin.

Todd is a most capable investigator; he has made fundamental contributions to organic and bio-chemistry and is recognized as a leader in these fields.

Royal Medal (B): Prof. V. B. Wigglesworth, C.B.E., F.R.S.

Prof. V. B. Wigglesworth has increased our knowledge of almost every branch of insect physiology, and in most cases his work has formed the starting point for other investigators. His contributions to the understanding of those interwoven subjects—growth and cuticle structure—are of paramount importance. It was Wigglesworth who first resolved the epicuticular layer into its four components, showing both the chemical composition and the biological role of these layers, and we owe to him our knowledge of the structure and functioning of the dermal glands. But the formation of the cuticle is inseparable from the study of growth, and following Kopec's first demonstration that hormones were involved in the growth process, the rest of this vast and complex subject belongs to Wigglesworth: the hormonal balance giving rise to nymph or adult, the individual fields of organization in the epidermis, the mechanism of the parallel case of wound healing, and most recently, the way in which various hæmocytes enter into the process.

In the study of respiration, too, Wigglesworth has been a pioneer, and his recent studies on the migration of tracheoles and the effects of low oxygen tensions on tracheal organization have altered our entire concept of this subject.

He has done fundamental work on the digestion of blood meals by parasitic insects, and has demonstrated the formation of a peritrophic membrane in many species by secretion through an annular press. The detailed picture of the histological and chemical cycle of excretion through Malpighian tubules, and the secretory balance of salts and water in mosquitoes are also noteworthy.

From the width of the field covered by his numerous researches, it can be said that Wigglesworth is the 'father' of insect physiology. He has realized the potentiality of the insect as a medium for physiological research, and carried that view into practice with a mastery of observational and experimental methods.

Davy Medal: Prof. H. W. Melville, F.R.S.

Prof. H. W. Melville occupies a prominent position among those who have developed the extremely important field of the chemistry of macro-molecular substances. He has made many valuable contributions to the study of the mechanisms of the reactions in which such substances are formed, and has devised new experimental methods for the purpose. His early work on the examination of the various explosion limits in mixtures of phosphorus vapour and oxygen confirmed and extended important results bearing on the early development of the theory of chain reactions, especially the role of diffusing atoms and radicals. With the discovery of deuterium he examined a number of reactions in which the replacement of hydrogen by deuterium contributed to the elucidation of the mechanism. His work on photochemical reactions sensitized with mercury vapour greatly advanced and clarified this problem.

With this background Melville took up the study of the more complex processes of polymerization and to this field he has made important and lasting contributions. He devised new techniques for the study of the elementary processes which make up the overall chain reaction, and he applied the device of the rotating sector to the determination of the life-time of transient entities. This work has formed the basis of the quantitative study of free-radical reactivity both for polymerization and oxidation systems and in many other reactions. Melville and his collaborators have also made valuable contributions to the methods of synthesis and study of new polymeric systems, including recently the interesting group of 'black polymers'.

Melville's achievements have contributed much to our knowledge of the intricacies of chemical change, and his development of new methods and techniques for research have had an influence far beyond the confines of his own laboratory.

Sylvester Medal: Prof. E. C. Titchmarsh, F.R.S.

E. C. Titchmarsh's early work was in the theory of Fourier series and integrals. From this he passed on to a profound study of the special properties of the Riemann zeta-function, a subject which he made very much his own over a period of many years. His systematic use of Fourier integrals, and in particular of Parseval's formula, led to formulæ that would not have been suggested naturally by other methods, and these formulæ proved to be remarkably fruitful for the development of new properties of the function.

Some of his work on the order of magnitude of the zeta-function was based on developments of methods of estimating trigonometrical sums, due originally to Weyl and van der Corput. He applied these ideas to other problems also, and in particular he effected significant improvements in the estimation of the error terms in lattice point problems by extending van der Corput's method to double trigonometrical sums.

His more recent work has been in the field of eigenfunction expansions associated with second-order differential equations.

Prof. Titchmarsh has also written a number of important treatises on the various fields within which he has worked.

Hughes Medal: Prof. H. S. W. Massey, F.R.S.

Prof. H. S. W. Massey has added greatly to our knowledge of collision processes between electrons, neutral particles and ions. His early work was concerned with elastic and inelastic collisions between electrons and atoms. With Bullard he was responsible for some of the early experiments demonstrating

diffraction effects. He carried out and directed a large number of detailed calculations, and, in particular, he exploited the variational method with great thoroughness, and did much to give a pattern to the experimental results by emphasizing the significance of the near-adiabatic conditions.

He was the first to apply the theories of attachment and recombination to problems of the ionosphere, and he led the way in reviewing the results of the radio experimenters and in trying to explain them. The difficulties in the way of explanation led him to investigate and discuss a wide range of atomic and molecular processes possible in the upper atmosphere. His work, and that of his pupils, is far in advance of any other in this field and has revolutionized our ideas about atomic processes in the ionosphere.

Prof. Massey is also the joint author of two important books on the subject of "Atomic Collisions" and of "Electronic Impact Phenomena".

FUNCTIONS OF THE ROYAL SOCIETY

A Royal Medal was awarded ten years ago to Sir Edward Salisbury for his contributions to botanical science. To-day if there were an appropriate medal we ought to give it to him for his contributions in a wider field, as Biological Secretary of the Royal Society. His term of ten years ends at this meeting. We shall all miss the wise counsel he has given the Society, and I count myself extremely fortunate to have held office with a colleague who has endeared himself to Officers and Fellows alike by his kindly understanding of our needs.

We rely on our Secretaries for much more than the supervision of meetings and publications, for they are constantly surveying our activities and must see to it that they are adapted to changing needs. Sir Edward's initiative has widened the scope of our meetings, he has maintained and extended our role in relation to the Commonwealth, and in the field of publications his care in the administration of the Parliamentary Grant-in-Aid has been largely responsible for the improved position enjoyed not only by ourselves but also by many other societies as well.

On behalf of the Society, therefore, I thank Sir Edward Salisbury for the valuable service he has rendered to science during his tenure of office as Biological Secretary.

The past year has seen a development in scientific activity which may have great consequences for all of us and I shall deal with it now because we are fortunate in having evidence of it at this meeting. I refer to the striking change which has come about in the field of international scientific effort. We have witnessed at Geneva a conference on the use of atomic energy at which the experts from every country could exchange information in the atmosphere of genuine scientific co-operation. The geophysicists, astronomers, meteorologists and geographers of every nation have already taken the first steps in their combined operations for the International Geophysical Year, and our own advance party, led by Surgeon Lieutenant-Commander Dalgliesh, is already on its way to the Antarctic, which is to be the scene of so much activity in 1957. In the less remote parts of the world, scientific delegations are now exchanging visits with an unaccustomed freedom, and we ourselves have been honoured by the visit of the President of the U.S.S.R. Academy of Sciences and his colleagues during the past fortnight and by their presence at our Anniversary Meeting to-day.

We ought to think of our future rather than our past, but this is an occasion when we cannot be blamed for recalling our long history. When Peter the Great was in London at the end of the seventeenth century, he may well have attended some of the Society's meetings, but unfortunately the names of our visitors then were not recorded. In 1714, however, his fellow-countryman, Prince Alexander de Menzikoff, was admitted a Fellow of the Society, and the notice of his election was signed by our president, Sir Isaac Newton.

When we turn to the record of scientific achievements in the past year it is more difficult to select those which would really justify the use of that overworked epithet 'outstanding'. The passenger who is driven in a modern car along an open road will expect the milestones to recur every minute and will feel that something has gone wrong if they do not. In the past year nothing has gone wrong with the progress of scientific research, in fact the pace is faster than ever; but we are already so used to it that we have come to think more of the danger signals than of the milestones. It is, of course, unfortunate that knowledge can be dangerous, and it would certainly be a disaster if this became an excuse for preferring ignorance; but the danger signals have already attracted world-wide notice and the Society will not need to be reminded of them.

The milestones may have attracted less notice than they deserve: each of us can think of important advances in the field he knows best; but there are two which deserve mention now because our own Fellows have made them and because they are signs of what is likely to be a new phase in our understanding of Nature. I refer to the recent elucidation of the structure of two highly complex molecules, those of insulin and of vitamin B_{12}. Both these substances are formed in living cells and play an important part in the vertebrate economy, insulin in sugar metabolism and B_{12} in the formation of the blood cells. Their existence has been known for many years, the use of the naturally occurring products has already saved a great many lives, and there is no immediate prospect of replacing the natural product with one made synthetically. But both are composed of very large molecules with a structure which has presented formidable problems to the chemist, and the solution of these problems cannot fail to enlarge our understanding of biochemical events.

The insulin molecule has a weight of more than 5,000, with two polypeptide chains of unequal length linked by sulphur groups: it has taken Dr. F. Sanger and his collaborators more than ten years to map the entire structure. The molecule of B_{12} has one atom of cobalt and sixty-three of carbon. Dr. Dorothy Hodgkin's X-ray analysis of the crystals has been a remarkable demonstration of the value of this method for mapping such complex molecules: another example of the same thing has been the research on hæmoglobin which Dr. M. Perutz has carried out at the Cavendish Laboratory under the inspiration of Sir Lawrence Bragg, and on the other hand, we have Sir Alexander Todd's studies of the B_{12} group and of the nucleo-proteins, as well as Sanger's of insulin, to show that the organic chemist has not yet lost the power to work out his own salvation by classical methods.

The structural formulæ of these molecules seem terribly elaborate to those of us who are not within the pale. We can applaud such triumphs of chemistry; but they force us to realize how much the living cell must depend on the interplay of very large molecules in which the detailed arrangement of the atoms is of truly vital importance. We may wonder how many such elaborate structures will have to be mapped before we can see the way to general principles; though we are glad to have passed the stage when all that was known of the biochemistry of protoplasm was contained in the two words 'anabolism' and 'catabolism'.

At all events, since the difficulties now are largely technical, it is a comfort to know that the attack on one technically arduous problem has always made it far easier to deal with others of the same order. The successful mapping of large molecules has needed courage and persistence as well as imagination; but the way to further maps will be made plainer. It is a comfort, too, to know that we can confidently expect the unexpected, the advance which may give these problems a new turn. Yet in spite of that, the biologist has little hope of escaping the immense variety of his material. Even when the molecular structures are mapped there will be the organisms to deal with, the vast range of plant and animal form and in the end the differences between one man and another.

Biology, however, is not the only field where there are large territories to be explored in detail before we reach the next eminence. In fact the present course of progress in natural science, rapid though it is, does not suggest that scientific research is likely to change its present specialized character. The regions to be covered become greater and greater, and most of them can only be dealt with by the particular group of experts who know their way into the area.

This brings me back again to an appropriate theme for our annual meeting, namely, the part which the Royal Society should play to fulfil its task of improving natural knowledge.

At the end of his term of office, it is to be expected that your President will have ceased to marvel at his presumption in accepting so exalted a position and will have had time to consider its responsibilities. He will not have had much time, for the work of the Society grows apace; but in spite of that the duties of the President are certainly less arduous than most people might suppose. He is supported at every turn by the knowledge of a great Society at his back and by the Council and the whole staff at Burlington House inspired by an Assistant Secretary with a genius for tactful and effective administration. In fact, the President is so well cared for that it is a wise regulation which sets a limit to his reign.

Fellows will not need to be told of the many fields of activity in which the Royal Society is now engaged. It dispenses grants, awards medals, publishes journals and holds its scientific meetings; but I am convinced that the most important thing it does now is to exist and to perpetuate its existence by electing new Fellows.

Our meetings and periodicals are no doubt the best evidence of our existence; but they are scarcely essential to it. Indeed, their scope needs constant adjustment if they are not to be submerged in the present flood of scientific activity. Every subdivision of science has now begun to organize its special conferences and lectures. With so many subdivisions and so much to publish, the customary medium for printed communications is either a journal devoted to one special field or one which will take the shorter papers and publish them with the least delay. I am not suggesting that our own meetings and journals could be abolished without great loss, but rather that we should continue our policy of arranging some meetings where the specialist is encouraged to state his case before an audience of fellow scientists who are not all fellow specialists. That is certainly an important task.

In electing new Fellows, however, we perform a task which becomes more and more important as natural science expands and subdivides. It is essential to its progress here that there should be a council of scientists of acknowledged reputation able to form an impartial judgment on the claims of every field and on the merits of those who work in them. Scientific issues are now of great concern to those who frame the laws and policy of the State, and there must be some independent body to advise on them.

Statesmen and lawgivers are not likely to need advice on the latest developments of scientific thought; if they were, they might get better advice from the younger generation who have been trained in modern ideas and techniques and are used to the present scale of laboratory work. What is needed, however, is not an academy to pronounce on the controversial points of scientific theory but one with a reasonable knowledge of the direction in which research is leading.

We as a Society have never aspired to an organized control of scientific research: even in times of grave national emergency, we have preserved our status as a private body willing to co-operate with the State but unwilling to forfeit our independence. It is, of course, true that the Fellows of the Society have always played a large part in directing research into fruitful channels; but they have done so as heads of laboratories, teachers and leaders of research teams. It is true also that we control funds entrusted to us by past benefactors and that many of these funds must be used for the furtherance of particular branches of science. The value of the funds we hold now amounts to more than a million pounds, and we have also to administer yearly government grants of more than £50,000 for aiding scientific research, scientific publications and international activities. These sums, however, are small compared with the total which must be spent annually by any country dependent on machinery, and with the political system of Great Britain it seems far better for the Royal Society to keep itself outside the State organization. The larger this becomes, the more important will it be for us to maintain our status as an independent body of scientists whose chief obligation is the advancement of knowledge.

It is neither necessary nor desirable for the Society to give any official ruling on scientific issues, for these are settled far more conclusively in the laboratory than in the committee room. This principle has been recognized by the Royal Society since its foundation and it is stated specifically in the advertisement to the *Philosophical Transactions* in 1753. This points out "that the certainty of the facts and the propriety of the reasonings contained in the several papers so published must still rest on the credit and judgement of their respective authors". The advertisement goes on to say "that it is an established rule of the Society, to which they will always adhere, never to give their opinion as a Body upon any subject either of Nature or Art, that comes before them". To make the position almost painfully clear, the advertisement goes on: "And therefore the thanks which are

frequently proposed from the chair, to be given to the authors of such papers as are read at their accustomed meetings, or to the persons through whose hands they have received them, are to be considered in no other light than as a matter of civility, in return for the respect shown to the Society by those Communications".

This stern insistence on our impartiality has not prevented us from issuing reports from time to time when the occasion seemed to demand them. There are, for example, the reports of the Food Committee during the First World War. But it has never been suggested that the Society assumed any other responsibility than that of choosing the committee of experts to draw up the report.

That, however, is the kind of obligation which the Royal Society should be specially fitted to discharge. It is right that the State should obtain the best scientific advice on practical issues, and it must know where to turn for the best panel of advisers. There are, of course, numerous societies to deal with particular fields, and some of these would be just as competent to nominate experts from their membership. But the fragmentation of science has left disputed borderlines as well as unclaimed territory, and if our Fellows have been properly chosen we should be able to justify the claim to represent all branches of science at the highest available level. Although we do not pronounce officially on matters of scientific controversy, we can say who are the leaders in any field and we know what sort of people they are.

If this were our only, or our principal, function it might seem to reduce our status to that of a scientific employment agency; but the applications of science are now of such consequence that the State must be forced to spend more and more of its income on science and technology. With scientists in short supply it must expand research, teaching and development. It must be careful not to harness too many active investigators to desks in Whitehall or to the committee rooms of universities, yet its administration must show an understanding of scientific needs. We cannot blame government departments and Ministers for mismanaging scientific affairs if we are unwilling to assume our responsibility for aiding them.

How far then does our constitution and our present practice fit us for such responsibilities? This year marks the death two hundred years ago of a great political scientist, the Baron de Montesquieu, a Fellow of the Royal Society who was renowned in every country for his analysis of the principles of government. Montesquieu came to us from France and was impressed by the precautions against autocracy inherent in the British constitution. It is true that his praise of the liberal form of government developed in Britain was linked with the suggestion that the weather had a great deal to do with it. He says: "In a nation so distempered by the climate as to have a disrelish of everything, even of life, it is plain that the government most suitable to the inhabitants is that in which they cannot lay their uneasiness to a single person's charge". But his analysis of our laws made him conclude that we were, or at all events had the opportunity to be, the freest country in the world and that it is in our nature to defend our liberties from autocratic control.

I do not think our procedure for the election of new Fellows could be made more representative than it is now. It may not be strictly democratic, for the election must be made by the existing Fellows, but we come from every field of natural science and our ages vary within reasonable limits. At present our youngest Fellow is thirty-one, and Council this morning authorized the dispatch of a letter conveying the congratulations of the Society to our colleague, Mr. H. N. Ridley, whose hundredth birthday falls on December 10. We have to be constantly on the watch to avoid neglecting the claims of scientists whose work cuts across the standard classification. But the machinery is elastic: I have seen it at work over a fairly long period and I have always been impressed by the individual capacity for honest judgment which goes to the formation of a collective opinion on scientific merit. It is certainly a responsibility which we do not take lightly, and it is right that it should occupy much of our time in the early months of the year. Whatever else we should be doing, this is time well spent.

But nowadays the Society has many other things to do, and I am not sure that we have evolved the system of self-government which enables us to give adequate consideration to all of them. Election to our Council must be governed by the need to keep a balanced representation of different branches of science. Council would soon become ineffective if its numbers were expanded to keep pace with every new development; but with a body of only sixteen members, apart from the Officers, to represent our 560 Fellows, it is naturally difficult for more than a small proportion of the Society to gain any insight into the way in which its business is conducted. For those who are chosen to serve on the Council the volume of business to be decided must often seem far too great for meetings which can rarely last much longer than 1½ hours and occur only twelve times a year. Naturally a great deal of the work falls on the Secretaries, who must be prepared with advice on many of the matters which do not involve major issues; but even though the Council is willing to accept this advice without lengthy discussion, there are certain important decisions to be made at each meeting, and it is very difficult to find the additional time needed for the discussion of more general problems. With the present growth of scientific effort, problems of general policy are bound to be in our minds, and I know that the President must often have seemed unduly repressive when there is a long agenda and the Council meeting must be ended in time for the Ordinary meeting of the Society.

I have no solution to offer which would not involve more time spent in committee rooms and less in our laboratories. That may be a burden which we must accept. But I would urge the Society that it should act only as an adviser, and should not be willing to accept the kind of detailed administrative work which it is sometimes asked to undertake. Our difficulties arise from the fact that our responsibilities have grown. We must be constantly on guard to see that we have the leisure to survey them.

My successor with his new Officers and Council will have troublesome decisions to face; but we need not fear that the Society will ever be in danger of becoming less representative of science as a whole or less important in the affairs of the country. Your President becomes increasingly aware of its importance as he learns the duties of his office. Some of them are onerous; but it would be absurd to suggest that he has a thankless task in representing our great and ancient Society. So in conclusion all that I need add is the earnest hope that my successor will find his position as enjoyable as I have found it during these past five years.

RESPONSES OF A FERN APEX TO DIRECT CHEMICAL TREATMENTS

By Prof. C. W. WARDLAW
Department of Cryptogamic Botany, University of Manchester

THE organization and morphogenetic activity of a fern apex, that of *Dryopteris austriaca* (*D. aristata*), have been further investigated by observing how it responds to direct applications of solutions of various organic substances. This work was undertaken, partly in an attempt to explore the concept of the apical meristem as a complex reaction system[1], and partly because the technique of organ-culture, though it has been a means of obtaining interesting and important information on growth, has thus far yielded little new information on the primary morphogenetic activity of the apical meristem. Thus, in aseptic culture media of highly diversified composition, the growth of excised fern apices may be increased, decreased or inhibited; but no fundamental change in their primary morphogenetic activity has been reported[2,3].

The present work was also prompted by the view that the important advances now being made in the chemical study of apices[4,5] should be complemented by experiments in which the more important metabolites disclosed by these and other studies should be applied directly to embryonic tissues (including embryos and meristems).

The first stage was evidently to ascertain if the fern apex does, in fact, react in novel ways to direct applications of different physiologically active substances. In the preliminary experiments briefly considered here, large apices of *Dryopteris austriaca* were laid bare, treated for periods up to about twenty days with solutions of substances such as 3-indoleacetonitrile, dinitrophenol, maleic hydrazide, yeast extract, glutamine, etc., retained in small pads of absorbent cotton wool, and examined at frequent intervals under a binocular microscope, with subsequent microscopic study of fixed and sectioned materials. Some work along the same general lines, both on apices and embryos, has already been reported by other investigators[6–9], and there is also a considerable literature on the morphogenetic effects induced by spraying physiologically active substances on older regions of the plant. Among the advantages of my procedure are that the very earliest visible evidence of any unusual morphogenetic development can readily be observed and that reactions of a transitory nature are not overlooked. (The general term 'apex' here denotes the distal region of the shoot, comprising the conical apical meristem and the wide subapical region. The apical meristem consists of a superficial layer of distinctive embryonic cells occupying most of the terminal conical region, the youngest leaf primordia arising within this meristem.)

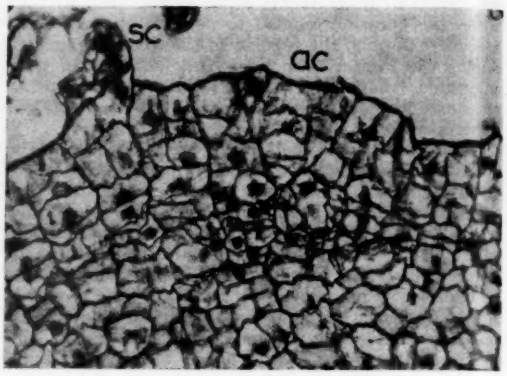

Fig. 2. Longitudinal median section of an apex treated with thiamine hydrochloride, showing the parenchymatization of the apical cell region (*ac*) and the precocious formation of scales (*sc*) over the meristem. (× *c.* 180)
(*Photos in Figs.* 2, 3, 5 *by Ernest Ashby*)

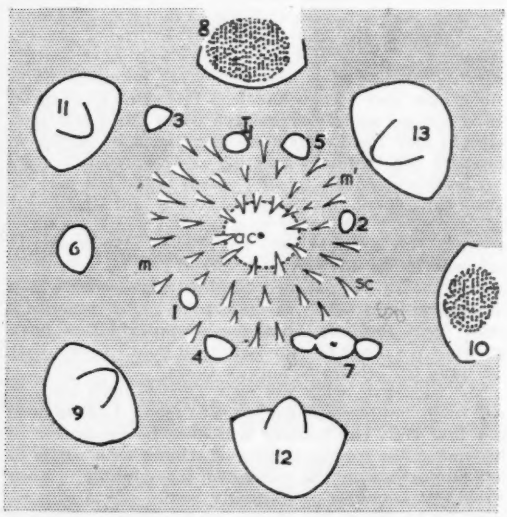

Fig. 1. *Dryopteris austriaca*. Apex as seen from above, after treatment with yeast extract. The original conical apical meristem, indicated approximately by *mm*[1], has become almost completely flat and scaly (*sc*) close to the apical cell (*ac*); primordia P_1–P_7 and the new primordium at I_1 have remained small and have become relatively widely separated; the apex of P_7 was slightly injured and two lateral primordia have formed; P_8 and P_{10} were damaged at the outset; the broad subapical region is stippled. (× *c.* 17)

Thus far, it has only been possible to test a limited number of substances; but in most cases some reaction was obtained, and already many developments of morphogenetic interest have been observed. These include: an increase in the rate of growth in the subapical region; an arrest or slowing down of growth in the apical meristem; the formation of flattened and of sunken, cup-shaped apices; the formation of double, treble and quadruple leaf primordia, of two primordia in a single leaf site, and of centric (or radial) leaves; the occasional suppression of primordia; the reversal of the phyllotactic spiral; the induction of buds on meristems with an uninjured apical cell; the promotion of root formation and growth; the formation of scales on the apices of young leaf primordia and leaf sites, and the precocious formation of scales (which are not present

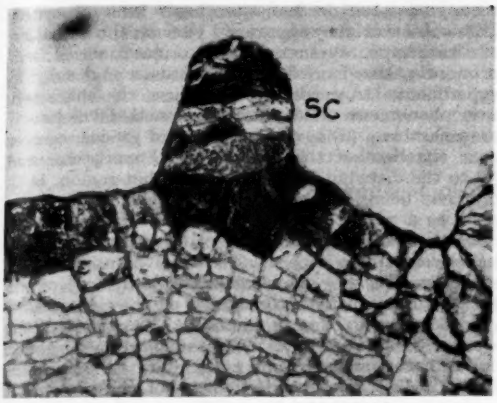

Fig. 3. Longitudinal median section of an apex treated with yeast extract. The region of the apical cell has lost its distinctive character: it is becoming parenchymatous and has given rise to a large spine-like scale (*sc*). (× *c.* 180)

on the normal apical meristem but only on the enlarging subapical region) over the whole of the apical meristem, including the apical cell; and the precocious parenchymatization of the meristem, including the apical cell.

Although some treatments have resulted in extensive morphological changes, nevertheless it has become evident that certain aspects of apical organization and activity are not readily modified. Thus, when apices were treated with yeast extract, or with thiamine hydrochloride, the meristem became scaly all over and parenchymatous (Fig. 1), the apical cell also became much divided (Fig. 2) and sometimes gave rise to a spine-like scale (Fig. 3). Buds, which never occur on the normal intact apical meristem, were sometimes formed on these apices. Nevertheless, these and other apices, in which extensive modifications were being induced, continued to give rise to leaf primordia in normal positions for some time. In some, usually vigorously growing, apices, there was sometimes a return to the normal organogenic activity when the treatment had been discontinued for some time.

The evidence thus far obtained indicates that the procedure adopted may well yield information on the organization and reactivity of the apical region that may not be forthcoming from organ- and tissue-culture investigations. An example may be cited. When autoclaved yeast extract was an ingredient of solid culture media in which excised (or explant) fern apices were being grown, the overall growth of the explant was greatly increased; but its morphological development was quite normal[9]. But when the same concentration of yeast extract (unautoclaved), or a solution of thiamine hydrochloride, was applied directly to the apex, the somewhat novel results indicated above were obtained (Figs. 1–3). It need scarcely be said that much further work is necessary to explore adequately this interesting aspect.

In earlier work, it was shown that certain characteristic morphological and histological developments can be induced at will by appropriate surgical treatments[10]. Comparable developments have now been obtained by the direct chemical treatment of the apex. If, for example, the shoot apical cell is punctured, or if it remains intact and active but is isolated from a young leaf primordium (P_1) or from a primordium site (I_1) by a deep and wide tangential incision, buds are usually induced in these and other positions[11]. In different chemical treatments (yeast extract, dinitrophenol, maleic hydrazide), in which the normal activity of the apical cell group was arrested or radically modified, buds were formed in P_1, I_1 and other positions (Fig. 4). On the evidence of the surgical experiments, the inhibition of buds in or near the apical meristem in the normal *Dryopteris* apex was attributed to the organization and growth of the apex as a whole and not to a *direct* inhibiting effect of an auxin, proceeding from the apical cell group, on a young primordium or primordium site[12]. The present experiments support this view: buds were not only formed around an isolated, intact apical meristem during continuous application of a range of physiological concentrations of 3-indoleacetonitrile and 3-indoleacetic acid, but also they grew vigorously and had a strong vascular development. Where the apex had been damaged, the vascular systems of these buds spread across the medulla of the parent shoot, Fig. 5.

In the normal development of *Dryopteris*, a steady relationship is maintained between the apical meristem and the subapical region, the embryonic cells near the base of the conical meristem being successively differentiated into the tissues of the subapical and maturing regions. Indeed, except for a gradual ontogenetic increase in size, the apex remains relatively unchanged in configuration and morphogenetic activity over many years. This steady relationship of the apical meristem and the subapical region, and the perennially embryonic condition of the former, have been more or less considerably modified by some of the direct chemical treatments given in these experiments. The effects observed can be referred, directly or indirectly: (1) to an increase in the relative rate of growth in the subapical region; (2) to an arrest of growth, or a greater relative

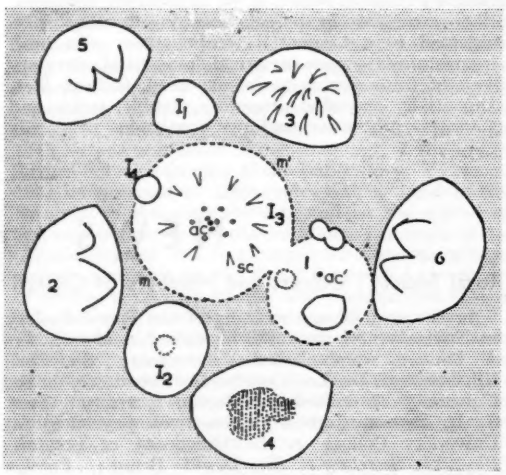

Fig. 4. Apex as seen from above, after treatment with dinitrophenol. Several of the primordia present at the beginning of the experiment have become double; the apex of primordium 3 (P_3) has become scaly; P_1 has become a bud, with three leaf primordia, the second of which is double; P_4 was damaged at the outset; the second new primordium (I_3) is centric and no primordium has been formed in the normal I_2 position; the apical meristem is becoming scaly (*sc*) and small scales can now be seen close to the apical cell (*ac*); the circular broken line (*mm'*) indicates approximately the base of the apical cone; the broad subapical region is stippled. (× *c.* 7·5)

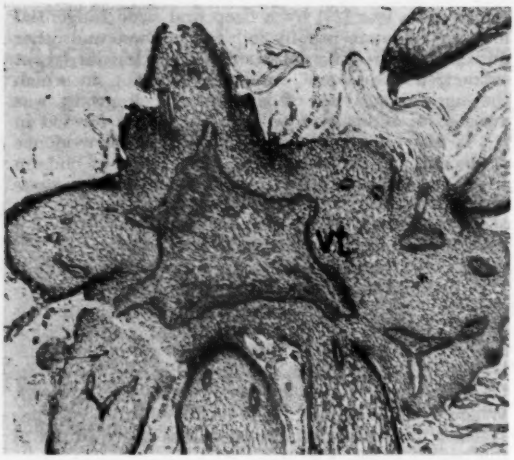

Fig. 5. Transverse section of a shoot in which the distal region of the apical meristem became damaged during treatment with 3-indoleacetic acid in lanoline. The several large buds which were formed close to the injured region have given rise to a large, stellate mass of vascular tissue (*vt*) in the medulla of the parent shoot. (× 12)

decrease in the rate of growth, in the apical meristem; (3) to a precocious parenchymatization of the meristem. In some instances processes (1) and (2) may both be involved. Where a rapid relative growth of the subapical region has been stimulated, as in treatments with indoleacetic acid and indoleacetonitrile, a depressed or cup-shaped distal region results, this being the normal conformation of the apex in some other large fern species. In (1) and (2) above, the young leaf primordia, which occupy positions in the transition zone between the slow-growing apical meristem and the more rapidly growing subapical region, may, in different instances, either participate in the enhanced development or be subjected to a tangential tensile stress. In both circumstances some abnormal tangential development of primordia is to be expected, and, in fact, tangentially extended primordia, double, treble and quadruple primordia, and two contiguous primordia occupying a single leaf site, have been observed. These observations support my view on the causation of the shape, symmetry and orientation of leaf primordia, based on direct observation and surgical experiments. According to this view, the characteristic phenomena of leaf formation and development are referable: (*a*) to the inception of growth centres near the base of the conical apical meristem, and (*b*) to the distribution of growth in that region, both of these being functions of the organization of the apex as a whole.

In these experiments some of the substances may have entered the superficial cells of the apical meristem directly, they may have entered by way of the subjacent parenchymatous cells, or they may have gained access by way of wounds. This aspect of the work, which carries its own interest, needs much fuller investigation. Some preliminary investigations have, in fact, been carried out. For the present, it may be noted that many different substances can enter the tissues of the apical meristem or the subjacent region and induce changes in its normal functioning. Accordingly, an intensification and diversification of work along the lines adopted in this preliminary exploration may well yield substantial information on the reactivity of cells in different regions of the apex and on the processes involved in the differentiation of embryonic cells. Contemporary investigations support the view that this is the kind of information that is now most needed if we are to make progress in elucidating the problems of morphogenesis.

A fuller account of these observations will be given elsewhere.

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NEWS and VIEWS

Royal Society: Officers and Members of Council

At the anniversary meeting of the Royal Society on November 30, the following officers and members of Council were elected: *President:* Sir Cyril Hinshelwood, Dr. Lee's professor of chemistry in the University of Oxford; *Biological Secretary:* Prof. G. L. Brown, Jodrell professor of physiology at University College in the University of London; *Physical Secretary:* Sir David Brunt; *Foreign Secretary:* Dr. H. G. Thornton, head of the Department of Soil Microbiology at Rothamsted Experimental Station; *Treasurer:* Sir Thomas Merton. *Other Members of Council:* Prof. T. A. Bennet-Clark, professor of botany in the University of London, King's College; Dr. B. Bleaney, demonstrator and lecturer in physics, University of Oxford; Prof. F. W. R. Brambell, Lloyd Roberts professor of zoology in the University of Wales at the University College of North Wales; Dr. Mary L. Cartwright, mistress of Girton College and University lecturer in mathematics in the University of Cambridge; Sir Alan Drury, member of staff of the Agricultural Research Council; Prof. J. H. Gaddum, professor of pharmacology in the University of Edinburgh; Sir Claude Gibb, chairman and managing director of C. A. Parsons and Co., Ltd.; Prof. L. Howarth, professor of applied mathematics in the University of Bristol; Prof. W. B. R. King, formerly Woodwardian professor of geology in the University of Cambridge; Prof. K. Mather, professor of genetics in the University of Birmingham; Prof. J. S. Mitchell, professor of radiotherapeutics, University of Cambridge, and director of the Radiotherapeutic Centre, Addenbrooke's Hospital, Cambridge; Prof. N. F. Mott, Cavendish professor of experimental physics in the

University of Cambridge; Sir Rudolph Peters, professor emeritus of biochemistry in the University of Oxford; Prof. J. M. Robertson, Gardiner professor of chemistry in the University of Glasgow; Dr. B. F. J. Schonland, deputy director, Atomic Energy Research Establishment; Prof. M. Stacey, professor of chemistry, in charge of organic and biological chemistry, in the University of Birmingham.

Sir Cyril Hinshelwood, F.R.S., President of the Royal Society

THE election of Sir Cyril Hinshelwood as president of the Royal Society will be acclaimed not only by his scientific colleagues, but also by the host of his past students, now dispersed in the chemical industry and elsewhere. As a fellow and tutor of Trinity College, and afterwards Dr. Lee's professor of chemistry at Oxford, his influence and inspiration have been profound. The dominant theme of his research has been the elucidation of chemical processes by kinetic methods, and much of it is characterized by a design which enabled him to obtain answers to questions of great complexity using relatively simple experimental technique. He first clarified the processes of molecular activation in homogeneous gas reactions, and made vital contributions to our understanding of thermal chain reactions. Similar considerations were then applied to reactions in the liquid phase. More recently, he has used the same systematic analytical approach in exploring the problems of bacterial growth, a method at first received with some scepticism by more professional biologists, but which has now led to results of fundamental value in connexion with processes of bacterial adaptation. His several authoritative books on these subjects are recognized by their eloquent clarity, and reveal his vividly philosophical approach towards the underlying unity and pattern of natural phenomena.

Sir Cyril's previous distinctions include the Davy and Royal Medals of the Royal Society, of which he has been foreign secretary for five years past, and others of the Chemical Society, of which he is a former president, as well as many other honours bestowed by foreign scientific academies. He has served on many government advisory bodies, was recently chairman of the Fuel Research Board, and is a member of the Advisory Council on Scientific Policy. To all these scientific qualities, Sir Cyril also adds a remarkable command of foreign languages, much achievement as a connoisseur of art and as a painter in oils, and a conversance with classical and modern literature in many tongues. Through his pursuit of natural knowledge and through his distinctive qualities, Sir Cyril is eminently fitted to uphold the high traditions of his new office.

Genetics at Glasgow: Prof. G. Pontecorvo, F.R.S.

THE establishment of a chair and the appointment of Dr. G. Pontecorvo as its first occupant complete the administrative arrangements for genetics at the University of Glasgow. A lectureship established in 1945, to which Dr. Pontecorvo was appointed, developed into a Department of readership status with increasing teaching commitments and with an active research school supported by the three Research Councils, the Nuffield and the Rockefeller Foundations and industry. The readership is now raised to the status of chair.

After graduating at Pisa—his birthplace—in 1928, Dr. Pontecorvo was engaged for about nine years in Florence in research on the applications of genetics to animal breeding. In 1938 he had to leave Italy as a consequence of political conditions, and found hospitality at the Institute of Animal Genetics, University of Edinburgh, then directed by Prof. F. A. E. Crew. There the opportunity of working on the genetic effects of radiations under the inspired leadership of Dr. H. J. Muller shifted his interests from applied to fundamental genetics. Since then Dr. Pontecorvo has held successive research and staff positions in Glasgow, Edinburgh, and finally in Glasgow again. His contributions to genetics are in several directions. He was one of the early investigators of the lethal effects of radiations in the first generation of irradiated individuals. With Muller he designed an ingenious method to investigate genetic differences between species the hybrids between which are sterile. With Prof. E. Hindle, he investigated the cytology of the human louse and the genetic mechanisms underlying its sex-ratios. In 1943 the demand for penicillin led him to work on the genetics of *Penicillium*. This marked the beginning of his interest in the genetics of fungi, both *per se* and as a powerful tool in investigating the ultra-microscopic organization of the gene. These two lines of interest have been pursued side by side for the past ten years by the research team led by Dr. Pontecorvo and including, among others, Dr. J. A. Roper. The work on the genetics of fungi has led to the discovery of alternatives to sexual reproduction in fungi in which this does not occur. The work on the gene has led to the view that it is a compound structure with many sites of mutation which crossing-over can distinguish from one another.

Colonial Section of the Road Research Laboratory: Dr. R. S. Millard

DR. R. S. MILLARD has been appointed head of the newly formed Colonial Section of the Road Research Laboratory with the rank of deputy chief scientific officer. Dr. Millard was educated at Queen Elizabeth Grammar School, Ashbourne, and at University College, London, where he obtained first-class honours in civil engineering in 1941. After experience with a civil engineering contractor, he joined the Bituminous Materials Section of the Road Research Laboratory, Harmondsworth, in 1944. In 1949 he was appointed officer-in-charge of the newly formed Scottish Branch of the Laboratory. In March 1951 he returned to Harmondsworth as head of the Bituminous Materials Section, and he has served in this capacity up to the present time. The tasks of the Colonial Section will be to apply the basic knowledge already available at the Road Research Laboratory to problems of road design and construction in the Colonies, and to extend this knowledge by research. The Section is being established at the Road Research Laboratory, Harmondsworth, where most of the laboratory work will be done. Field-work and full-scale road experiments in collaboration with the Colonies themselves will form an important part of the work of the Section.

Textile Institute: Supplemental Royal Charter

THE authority of H.M. the Queen has been given for the granting to the Textile Institute of a supplemental royal charter, extending the powers granted to it by the original charter of 1925. The supplemental charter authorizes fellows and associates of the Institute to practise and describe themselves as chartered textile technologists, and new by-laws

provide that the Institute may elect 'companions', an honour conferred on members who, while not being chartered textile technologists, have yet advanced the general interests of the textile industry. The Institute is also now authorized to grant the status of licentiate to members who have attained the age of twenty-three and have obtained such certificate or diploma as the Institute may consider to provide sufficient evidence of education in textile subjects.

Commonwealth Fund Grants for Medical Education in the United States

The Commonwealth Fund, New York, has given 7,150,000 dollars to ten university medical schools in the United States, to be used as the recipients deem wise, for strengthening their medical education programmes during the next few years. These special grants, which have been drawn from capital, are in addition to the Fund's annual contributions from its income, totalling 2 million dollars during the past ten years, to specific medical education projects, community health services and other traditional interests normally supported from current income. The medical schools receiving the new grants are: Chicago, 500,000 dollars; Columbia (Physicians and Surgeons), 750,000 dollars; Cornell, 750,000 dollars; Emory, 600,000 dollars; Harvard, 1,000,000 dollars; New York University, 750,000 dollars; Southern California, 300,000 dollars; Tulane, 750,000 dollars; Western Reserve, 1,000,000 dollars; and Yale, 750,000 dollars. The Commonwealth Fund was established in 1918 by Mrs. Stephen V. Harkness with the motto, "To do something for the welfare of mankind". During recent years its primary interests have been in the field of health, particularly in medical education, medical research and community health.

Vannevar Bush Fellowships in Earth Sciences

The Department of Geology and Geophysics of the Massachusetts Institute of Technology and the Geophysical Laboratory of the Carnegie Institution of Washington are co-operating in the award of pre-doctoral fellowships in theoretical and experimental geology. The award will be known as the Vannevar Bush Fellowships in Earth Sciences, in honour of Dr. Vannevar Bush, who has given long service as professor and, later, dean and vice-president of the Massachusetts Institute of Technology and more recently as president of the Carnegie Institution of Washington. In general, recipients will spend at least three or four terms in the Carnegie Institution doing laboratory work and one or two terms in the Massachusetts Institute analysing and writing up their results. Throughout their work they will be registered full-time candidates for a Ph.D. of the Massachusetts Institute and will be under the supervision of a senior member of the Department of Geology and Geophysics there. The value of the fellowships will be 200–225 dollars a month. Further information can be obtained from the Chairman, Department of Geology and Geophysics, 24–302 M.I.T., Cambridge 39, Mass.

Instrumentation and Accessories for Radioactive Isotopes

The Scientific Instrument Manufacturers Association, in collaboration with the United Kingdom Atomic Energy Authority, has published a most useful brochure, "Radio Isotope Instrumentation and Accessories" (pp. 124; from the Association, London; 1955), which will be of great assistance to the potential user of radioactive isotopes in selecting electronic equipment to suit his special needs. Compiled by Dr. D. Taylor and Mr. A. G. Peacock, the brochure contains an introductory section in which fundamental data with regard to radioactive measurements and instrumentation are discussed and shown graphically or in tabular form, followed by a series of manufacturers' illustrated announcements and specifications of nucleonic and electronic equipment. Details are given of the various detector elements and associated apparatus used for radioactive assay and radiation monitoring, and of the availability of special equipment for research in nuclear physics and radiochemistry. Inquiries regarding the equipment described should be addressed directly to the manufacturers concerned; but special inquiries may be sent in the first place to the Head of the Electronics Division, Atomic Energy Research Establishment, Harwell. Information and advice concerning the availability and uses of the isotopes themselves are not given in the brochure, but can be obtained from the Isotope Information Office at Harwell.

Scottish Field Studies Association

The Scottish Field Studies Association has now been in existence for six years, and during that time, and in face of great difficulties, has done much to extend interest in natural history in Scotland. Perhaps less well known than the field centres in England and Wales, the Scottish Centre at Garth has continued to develop in spite of the fact that use has to be made of a working youth hostel for accommodation and that a warden could only be appointed on a part-time and often voluntary basis. Besides five open courses, seven schools or colleges made use of the centre, giving a total of 1,450 student-days spent at Garth in 1954, an increase of 150 over 1953. The Association now feels that the arrangement at Garth is unsuitable, and one of its most active members, C. I. C. Murdoch, makes a powerful case for the setting up of a permanent centre in upper Speyside between the three great hill masses of the Monadhliaths, the Grampians and the Cairngorms; other members of the Association are keen on developing a centre in North Argyll. All who are interested in the setting up of a permanent field centre in Scotland or wish to develop field studies are invited to get in touch with the secretary of the Association, B. W. Gibbons, Department of Botany, The University, Glasgow, W.2.

Schools Service of the National Museum of Wales

The Schools Service of the National Museum of Wales covers the whole of Wales and Monmouthshire and is thus national in scope. It began in 1949, and it is appropriate that an attractive illustrated brochure about it should now be published under the title of "The First Five Years" (pp. 12; from the Museum, Cardiff; 1955; 6*d*.). The position to-day is that there are five officers, and every term more than two thousand exhibits are distributed between the secondary schools of the area served. The number of eligible schools is 365, of which more than half take part in the Service. The personnel and administration have been added to the already crowded Departments of the Museum, though during the period under review it has been found possible to construct a special room for the craftsmen and also provide a new garage for the two vans. Recently some basement accommodation was adapted to form a store

with its own entrance and assembly point. The service is intra-mural as well as extra-mural, and large numbers of school classes are received in the Schools Service Reception Room. Naturally, this part of the Service is of greatest use to the Cardiff schools. The aim of the Service is "to teach, to interest, and to inspire through objects". It is pleasing to note that this aim has been faithfully followed throughout the five years, for it is the fundamental aim of all museum work. Although the Service was designed to help the schools, it is also interesting to recall that it has been of reciprocal service to the Museum, and many objects of value have been offered by discerning children.

Self-Inhibition in Germinating Rust Uredospores

It has been observed that germinating uredospores of rust fungi produce a volatile substance which, under certain conditions, inhibits the elongation of the germ tube. This phenomenon has now been investigated in greater detail by F. R. Forsyth (*Canadian J. Bot.*, **33**, 5, 363; 1955). He reports that the self-inhibition of germination of uredospores of *Puccinia graminis* Pers. var. *tritici* Erikss. and Henn. has been consistently demonstrated in Warburg flasks. Four ways of overcoming the effect of the inhibitory substance have been discovered: the use of a sufficiently large volume of water in relation to weight of spores; the placing of a silver nitrate solution in the centre well; and the introduction of acetone or ammonia vapour into the flask atmosphere. The vapour of trimethylethylene inhibits germination of the uredospores in the same way that the natural inhibitor does, and the same means can be used for counteracting its effects. The similarity of the absorption spectra of the inhibitor and of trimethylethylene in acetone solutions indicates that trimethylethylene is the natural inhibitor. Cyclohexene has formative and inhibitory effects on the germ tubes, and these effects can be overcome by vapour of acetone.

Physiological Genetics of the Garden Pea

In grafting experiments using early and late varieties of *Pisum*, D. M. Paton and H. N. Barber (*Austral. J. Biol. Sci.*, **8**, 2, 231; 1955) have found that when genetically early scions of *P. sativum* var. Massey are grafted on to genetically late stocks of var. Telephone, flowering on a higher node results. In reciprocal grafts, the scions of the late variety flower at an earlier (lower) node. Control grafting, that is, scions to stocks of the same variety, has no effect on Massey scions but leads to flowering at a lower node in the Telephone scions. Removal of cotyledons as soon as possible after germination (3–7 days) has no effect on Massey but leads to earlier flowering in Telephone. The authors consider that these results are best explained on the assumption that the genetically later variety produces a flower inhibitor (or delaying) substance which can pass a graft union and alter the flowering behaviour of genetically early scions.

Meteorological Observations of Solar Radiation during an Eclipse

A paper by R. Dogniaux on "Observations of the Solar Radiation during the Eclipse of the Sun on June 30, 1954" (Pub. No. 13, Sér. *B*, Institut Royal Météorologique de Belgique, Bruxelles) describes the results of determining the radiations of the sun during the greatest phase (0·774), at Uccle, of the eclipse of June 30, 1954. Six figures show the results under various conditions, and from them the reductions in brightness during the course of the eclipse were calculated. The direct solar radiation was reduced to 14 per cent at the instant of greatest phase, diffused radiation to 35 per cent, and the total brightness to 25 per cent. With the aid of photo-electric cells, similar observations of the radiations to which the human eye is sensible were made, and it was found that these were reduced to 20, 28 and 12 per cent for the total, diffused and direct radiation on a horizontal surface, respectively. One of the figures shows the temperature reductions during the eclipse under a ventilated shelter on a platform, at a distance of 1 cm. under bare ground and also at a distance of 1 cm. under grass. Although it is certain that the effect of the eclipse is shown in the changes of temperature, and in particular under the bare earth, as revealed by the first graph of this figure, it is impossible to decide what percentage of this was actually due to the eclipse. The variation of cloudiness was such that its effect was very pronounced; nevertheless, the results show that the propagation of the heat differed for air, bare soil, and soil protected by grass.

Thirtieth International Congress of Americanists: Proceedings

The thirtieth International Congress of Americanists met at Cambridge in August 1952, under the presidency of Mr. J. Eric S. Thompson, the distinguished Maya epigraphist, and the proceedings have now been published (pp. 250. London: Royal Anthropological Institute). Americanist Congresses, which in the words of their statutes have for their object "the historic and scientific study of the two Americas and their inhabitants", normally take place every two years and alternate between the Old and the New World. The thirtieth Congress was the first to meet in England since 1912, when the eighteenth Congress met in London. The terms of reference of these Congresses admit a wide range of subjects, and only a few of the thirty-seven published papers can be mentioned here. By far the most interesting communication is an account of the recent explorations at the great Maya site of Palenque by Señor Alberto Ruz, in which he describes the discovery of an important burial chamber beneath the Temple of the Inscriptions, an outstanding instance of the rare practice of burying notable people beneath an American temple-pyramid. There are several other papers in the Maya field, including one on the Maya character by Mr. Thompson. Other interesting archæological papers are on the excavation of a shell mound, or sambaquí, in Brazil, by Prof. L. de Castro Faría, and on transport in Peru, by Dr. Paul Kosok. In linguistics there are two papers on Alaskan languages by Prof. L. L. Hammerich; in ethnology a study of the peyote cult by Dr. Ruth Underhill; and on the historical side a note by Dr. M. Ballesteros-Gaibrois on a manuscript of Fray Martín de Murúa, "Historia General del Perú", in the possession of the Duke of Wellington. Mr. Thor Heyerdahl has three papers relating to his theories of the population of Polynesia by voyagers from South America, which aroused some popular interest at the time of the Congress, although he had as 'rough' a time in the discussions as ever he had on the Kon Tiki raft. A feature of the Congress was a notable loan exhibition of nearly all the ancient Mexican manuscripts in Great Britain, to which was

added a series of fine unpublished drawings from the North American and Brazilian expeditions of Maximilian, Prince of Wied. The papers include a comment on these by Dr. J. Röder and a biographical note on his ancestor by Karl Victor, Prince of Wied. The publication of these proceedings was considerably delayed, and the thirty-first Congress was held at São Paulo before they appeared. The thirty-second Congress, to be held in Copenhagen, has been announced for August 1956.

Geographical Association : Annual Conference

The annual conference of the Geographical Association will be held in the London School of Economics, Houghton Street, London, W.C.2, during January 3–6, 1956. The presidential address, by Mr. L. S. Suggate, will be on "Aspects of Geography Teaching in Schools". In addition to the usual lectures, sectional meetings, excursions, etc., a joint meeting with the Royal Geographical Society and the Institute of British Geographers will be held in the former's premises in Kensington Gore, London, S.W.7, at which "Some Medical Aspects of Geography" will be discussed. Further information can be obtained from the honorary conference organizer, R. C. Honeybone, University of London Institute of Education, Malet Street, London, W.C.2.

The spring conference of the Association will be held at Brighton during April 3–7, 1956, and the programme and reservation leaflet for this meeting will be issued with the January issue of the Association's journal, *Geography*.

Cloud Physics : Conference in London

A conference on "Cloud Physics", arranged jointly by the Physical Society and the Royal Meteorological Society, will be held in the Department of Meteorology, Imperial College of Science and Technology, London, S.W.7, during January 4–5. After an introductory talk by B. J. Mason (Imperial College) on the scope of cloud physics, the first half-day will be devoted to the atmospheric aerosol, with papers by C. Junge and H. Weickmann (both of the United States) on, respectively, the nuclei of atmospheric condensation and the constitution of non-precipitating clouds. For the remaining day and a half the microphysics of clouds will be considered, with papers by the following : B. J. Mason, R. Braham (United States), F. E. Ludlam (Imperial College), J. S. Marshall (Canada) and J. T. Wormell (Cambridge). The meeting will be open to non-members. Application forms, to be returned by December 15, can be obtained from Miss E. Miles, Physical Society, 1 Lowther Gardens, London, S.W.7.

The Queen's University of Belfast

The following have been appointed to lectureships in The Queen's University of Belfast : Dr. R. J. Magee (inorganic chemistry), Dr. M. F. Grundon (organic chemistry), J. M. Gilchrist and Dr. W. F. K. Kerr (mechanical engineering), J. M. W. McBride (light electrical engineering), and Dr. D. S. McIlhagger (electrical engineering). The University has received the following grants : to the Department of Applied Mathematics, £2,250 from H.M. Treasury for a rocket research project with which the Department of Physics will be associated, and £1,200 in connexion with the International Geophysical Year ; to the Department of Organic Chemistry, £500 a year from the Medical Research Council for work on branched-chain carbohydrates, and £450 a year from the British Empire Cancer Campaign for work on the synthesis of colchicine.

Announcements

Sir Harold Roxbee Cox will deliver the twentieth Parsons Memorial Lecture at the Institution of Civil Engineers on December 13 ; he will speak on "The Development of the Gas Turbine".

Dr. E. J. Bourne, reader in organic chemistry in the University of Birmingham, has been appointed to the University of London chair of chemistry tenable at the Royal Holloway College in succession to the late Prof. Gwyn Williams.

The Massachusetts Institute of Technology has appointed Dr. R. R. Doell and Dr. J. W. Winchester to be assistant professors in the Department of Geology and Geophysics. Their subjects are seismology and geomagnetism, and nuclear geochemistry, respectively.

The Meldola Medal, which is the gift of the Society of Maccabæans, is being offered for award early in 1956 to the chemist who, being a British subject and less than thirty years old on December 31, 1955, shows the most promise, as indicated by published chemical work brought to the notice of the Council of the Royal Institute of Chemistry before December 31. Communications should be addressed to the President, Royal Institute of Chemistry, 30 Russell Square, London, W.C.1, the envelope being marked "Meldola Medal".

Sir George Beilby Memorial awards, which are considered at intervals by administrators representing the Royal Institute of Chemistry, the Society of Chemical Industry and the Institute of Metals, are made to British scientific research workers, preference being given to investigations relating to the special interests of Sir George Beilby, including fuel economy, chemical engineering and metallurgy. In general, the awards are given to younger workers for original investigations over a number of years. For awards early in 1956, the attention of the administrators should be directed, before December 31, to outstanding work of the nature indicated, all communications being addressed to the Convener of the Administrators, Sir George Beilby Memorial Fund, Royal Institute of Chemistry, 30 Russell Square, London, W.C.1.

A summer school on the applications of spectroscopy to chemical problems and on intermolecular forces and the properties of fluids will be held in the Department of Physical Chemistry, University of Cambridge, during August 18–25, 1956. Among the lecturers will be Prof. R. G. W. Norrish, Mr. R. P. Bell and Prof. H. C. Longuet-Higgins. Full opportunity will be provided for discussions. Further information can be obtained from the Secretary of the Summer School, Department of Physical Chemistry, Free School Lane, Cambridge.

The Manchester and District Section of the Royal Institute of Chemistry is organizing an exhibition of laboratory apparatus and techniques with particular reference to instrumentation, to be held in the Manchester College of Technology on January 4 (2–8 p.m.) and January 5 (10 a.m.–8 p.m.). Some thirty-five exhibitors are taking part, and there will be various demonstrations (for example, glass-blowing and vapour-phase chromatography).

INTERNATIONAL COSMIC RAY CONFERENCE

MEXICO MEETING

SINCE the War, a series of international conferences on cosmic rays has been organized by the Cosmic Ray Commission of the International Union of Pure and Applied Physics. These conferences have been arranged at two-yearly intervals, the first being held in Cracow in 1947, the second in Como in 1949, the third in Bombay in 1951, and the fourth in Bagnères de Bigorre in 1953. This last conference was almost exclusively concerned with the fundamental particle aspect of cosmic ray physics, although there was a small parallel meeting on time-variations of the cosmic ray intensity.

In contrast to the Bagnères de Bigorre meeting the topics chosen for the 1955 conference were the composition and energy spectrum of the primary radiation, geomagnetic effects, variations of the intensity with time and, finally, the problem of the origin of the radiation.

The conference was held in Guanajuato, a beautiful old Colonial town some 300 miles north of Mexico City, during September 5–13, and was made possible by generous grants from the Mexican Government and from Unesco. The meetings were held at the University of Guanajuato, where facilities were kindly provided by the rector, Lic. Antonio Torres Gomez. The detailed arrangements for the conference were made by Prof. M. S. Vallarta and the president of the Cosmic Ray Commission, Prof. P. M. S. Blackett. In addition to some sixty cosmic-ray physicists working on the topics covered by the conference, a number of astronomers (Brown, Chandrasekhar, Gold, Kiepenheuer, Oort, Schluter, Unsöld and Van de Hulst) also attended, and the meeting provided a valuable opportunity for joint discussion of problems of common interest.

The first day of the conference was devoted to papers and discussion on the composition and flux of the primary radiation and on the influence of the earth's magnetic field on the intensity of the radiation. Some recent work by the Iowa group was described which confirms the presence of a soft radiation in the auroral zone at altitudes greater than 50 km. It is believed that this radiation consists of electrons of rather low energy, which may belong to the high-energy tail of the auroral particle spectrum. The question of the abundance of lithium, beryllium and boron in the primary flux was discussed at some length, but the proportion of these elements present is still in doubt. The results of a recent latitude survey carried out by the Chicago and Ottawa groups using shipborne neutron monitors and meson telescopes were reported. The position of the geomagnetic equator deduced from these measurements appears to differ from that corresponding to the dipole field deduced from magnetic measurements, leading to an apparent discrepancy of as much as 7° in the geomagnetic latitudes of some stations.

The energy spectrum of the primary radiation was discussed on the second day. Data were presented by a number of workers on the low-energy end of the spectrum. In particular, the position of the knee in the intensity versus latitude curve was discussed; and evidence was presented showing that the position of the knee changes with time, being virtually absent at sunspot minimum, so that the intensity of the low-energy cosmic radiation was greatly increased at this time. The spectrum at high energies is deduced from measurements on large air showers, and several arrangements which are at present being used for the study of these showers were described. The radial density distribution of particles in showers of energy in the region of 10^{17} eV. has been investigated at Harwell and also by Russian workers using large counter arrays; some evidence was presented by the Harwell group for the existence of showers of energy 10^{19} eV. Some preliminary results were reported by the group from the Massachusetts Institute of Technology, which has recently completed a shower detector consisting of twenty large scintillator units. There was some discussion on the estimation of the primary-particle energy responsible for a given shower size, and there seemed to be general agreement among the different workers that the primary energy is given by the total number of particles in the shower multiplied by a factor of about 10^{15} eV.

The third and fourth days of the conference were taken up with the reporting and discussion of time variations of the cosmic-ray intensity. This session began with a discussion of meteorological effects on the sea-level intensity, in particular the relation between the intensity and atmospheric temperature. Then followed a series of contributions on the relation between the intensity and solar and geomagnetic activity. There were papers on cosmic-ray production associated with solar flares, intensity changes at the time of magnetic disturbances and the world-wide variation in the cosmic-ray intensity over the past solar cycle as recorded by the Carnegie Institution of Washington at a series of stations which have been in operation since 1936. Data from these stations show a variation in intensity during the solar cycle of about 4 per cent, maximum intensity occurring at the time of sunspot minimum. Discussion of the causes of these variations of intensity was mainly in terms of the possible effects of ejected solar material carrying magnetic fields out into interplanetary space, although there was no general agreement as to the precise way in which these fields produced the observed variations.

The fourth day was devoted to papers and discussion on the solar daily variation and its behaviour in relation to solar and geomagnetic activity, the sidereal daily variation and measurements on the isotropy of the high-energy particles producing large air showers. The anisotropy of the primary radiation in relation to the Sun, as evidenced by the presence of a solar daily variation, is well established; but as yet there is no general agreement on the existence of a sidereal daily variation. A new approach to the problem of the isotropy of the primary radiation at high energies lies in the measurement of the directions of arrival of large air showers, using techniques permitting an angular resolution of 5° or so. Some preliminary results of measurements of this kind were reported by the groups from the Massachusetts Institute of Technology and from the Imperial College of Science and Technology, London; but no definite anisotropy has so far been established with certainty.

The remaining time at the conference was allotted to contributions on theories of the origin of the primary radiation. This session began with introductory papers on the properties of the galaxy, the interstellar gas and the solar atmosphere. Prof. J. H. Oort described some recent work at Leyden confirming earlier results by Russian workers on the polarization of the light from the Crab nebula. The mean polarization over the central region of the nebula is 17 per cent; but there are indications that where a limited volume of the nebula can be isolated the polarization may be complete. Oort pointed out that it is possible to account for both the polarization at optical wavelengths and the observed intensity of radio noise if it is assumed that the emission is due to radiation from electrons of energy $\sim 10^{11}$ eV. spiralling in a magnetic field of 10^{-3} gauss. If this interpretation is correct, it opens up the interesting possibility that the Crab nebula may be a source of part of the cosmic radiation. The papers and discussion on the origin of the radiation left little room for doubt, however, that this problem still remains largely unsolved and is likely to feature as a subject for discussion at perhaps more than one cosmic-ray conference in the future.

The conference lasted for six days, and it will be appreciated that in a report of this length it has only been possible to mention a few of the many important contributions, selected in order to illustrate present trends in these fields.

SECOND INTERNATIONAL SEAWEED SYMPOSIUM

FOLLOWING the suggestion put forward at the first International Seaweed Symposium, held in Edinburgh in 1952 (see *Nature*, **170**, 478; 1952), the Norwegian Institute of Seaweed Research (Norsk institutt for tang-og tareforskning) arranged the second such symposium in Trondheim during July 14–16, when about a hundred and twenty scientific workers and industrialists from all over the world attended. In his opening address, Prof. Trygfe Braarud, chairman of the Board of Management of the Norwegian Institute of Seaweed Research, welcomed the delegates to Norway.

At the first session, dealing with "Algal Chemistry", Dr. E. E. Percival (Scotland) opened the proceedings with a paper on the polysaccharide sulphuric acid ester of the green alga, *Cladophora rupestris*, hydrolysis of which revealed L-arabinose, D-galactose, D-xylose, L-rhamnose and D-glucose, this being the first reported occurrence of arabinose in a seaweed polysaccharide; attempts to elucidate the structure of this complex polysaccharide by standard procedures were described. Dr. E. T. Dewar (Scotland) discussed the preparation, estimation and use of sodium laminarin sulphate as a heparin-substitute for preventing blood from clotting. The production of antibiotic substances by seaweeds was the subject of a paper by Prof. C. G. C. Chesters (England), in which certain littoral and sublittoral seaweeds have been examined for bacteriostatic activity; *Polysiphonia fastigiata* and *Halidrys siliquosa* are particularly good sources, and there is evidence of seasonal variation of antibiotic substances. The distribution of microbiological growth factors related to vitamin B_{12}, folic acid, folinic acid, niacin and pantothenic acid in the Rhodophyceae, Phaeophyceae, Chlorophyceae and Heterokontae was discussed by Prof. H. Lundin (Sweden) in a paper with L.-E. Ericson. The red and green algae generally contain higher amounts of vitamins than the brown algae, the maximum B_{12} content being possessed by *Vaucheria dichotoma* (2·8 μgm./gm. dry weight). The origin of vitamin B_{12} factors is believed to be the bacteria living epiphytically on the plant, the algae merely concentrating and storing the vitamin but not synthesizing it. The carotene and carotenoid content of seaweeds was dealt with in two papers (by A. Haug and B. Larsen, and S. Liaaen and N. A. Sørensen). Mr. Haug (Norway) discussed the carotene content of *Pelvetia canaliculata*, *Fucus vesiculosus*, *F. serratus* and *Rhodymenia palmata*, the quantity in the fresh algae being generally much higher than in the dried materials and commercial seaweed meals; drying and storing conditions are important factors in carotene breakdown. Prof. Sørensen (Norway) dealt with the carotenoids of fresh *F. vesiculosus* and conditions leading to the formation of zeaxanthin; it is now believed that this pigment is formed from violaxanthin, and not fucoxanthin as originally suggested. Low-molecular carbohydrates were reviewed by Dr. B. Lindberg (Sweden), who has shown that the mono- and di-β-D-glucosides of mannitol are characteristic of many Phaeophyceae, while *P. canaliculata* also contains the corresponding glucosides of D-volemitol; brown algae possess 'laminitol', a *C*-methyl inositol. The glyceric acid – mannose glycoside of red algae is proved to be 2-D-glyceric acid α-D-mannopyranoside, while two recently isolated glycosides are floridoside-α-mannoside and 'isofloridoside' (1-glycerol-α-D-galactopyranoside). The taxonomical value of these compounds was discussed.

Dr. F. T. Haxo (United States), in a paper with C. O hEochdha, reviewed the constituents of *Porphyridium cruentum*, a unicellular red alga which grows well but not prolifically in mineral-enriched seawater. The culture medium becomes viscous due to the presence of extra-cellular mucilage, which consists in part of a sulphated polysaccharide containing glucose, galactose, xylose and a uronic acid. Pigments include chlorophyll *a*, β-carotene, zeaxanthin and possibly lutein, while chromoproteins consist of a phycoerythrin and two phycocyanins. Three papers (by D. B. Smith, A. N. O'Neill and A. S. Perlin; S. T. Bayley; and W. Yaphe), read by Dr. E. Gordon Young (Canada), were devoted to the structure and degradation of carrageenin. By fractionation with potassium chloride, this polysaccharide has been separated into a potassium-sensitive fraction (*K*-carrageenin) and a potassium-insensitive fraction (λ-carrageenin); the former contains 3 : 6-anhydro-D-galactose and sulphated D-galactose residues in nearly equal proportions, while the latter appears to be mainly a sulphated D-galactose polymer. It is interesting to note that this anhydro-sugar in carrageenin is the enantiomorph of that present in agar. Useful information on the structure of the two fractions has been obtained by X-ray and infra-red studies. Bacteria capable of hydrolysing carrageenin and agar have been isolated from sea-water and marine algae; the cell-free enzyme solutions are specific for the respective polysaccharides, and have been used to identify agar and carrageenin in red algal extracts. Examination of the breakdown products should yield fruitful results.

Dr. Young, in a paper with D. L. Vincent and D. A. I. Goring, described the comparison of sodium

alginate samples from different species by examination of optical rotation, viscosity, ionic mobility and sedimentation-rate; viscosity is still the best criterion of degree of polymerization. Mr. A. Jensen (with I. Sunde, of Norway) gave details of the quantitative determination of alginic acid in seaweed samples by decarboxylating the mannuronic acid residues with 19 per cent hydrochloric acid and measuring the carbon dioxide potentiometrically. The method is convenient for routine analysis and is claimed to be more accurate than either the titrimetric or colorimetric procedure. The qualitative detection of small quantities of alginates in food, cosmetic and other products is often a matter of some difficulty, and consequently great interest was shown in a new method demonstrated by Mr. R. H. McDowell (England), in which the small quantity of alginate present is converted to calcium alginate, and the invisible precipitate is then rendered visible as characteristic blue flocs by the addition of the dye, 'night blue'; by this means, as little as one part of alginate in a hundred thousand of solution can be detected. The detection of alginic acid in tissues by means of polarization optics was demonstrated in a series of slides by Dr. G. Andersen (Germany), whereby alginic acid, by virtue of its unique birefringent properties, is proved to occur in the middle lamellæ and primary cell-walls of the Phaeophyceae and is not accompanied by insoluble admixed 'hemicelluloses'.

The reaction of stearyl chloride on alginic acid was discussed by Mr. L. F. de Keyser (Belgium), the resulting ester being fractionated with ether to give the distearate and lower ester fractions. The seasonal variation in chemical composition of brown algae was the subject of papers by Mr. A. Haug (Norway) and Dr. C. Primo (Spain, read by Dr. J.-M. Perelló), and the results were compared with those of previous workers. The decomposition of alginates and laminarin by micro-organisms occurring on decaying seaweed and in maritime muds was discussed by Prof. C. G. C. Chesters (England), the techniques used for assaying 'alginase' and 'laminarinase' activity being demonstrated. The results of chemical investigation of the decomposition products should yield valuable information on the structure of these two polysaccharides. The economics of the large-scale production of mannitol and laminarin from aqueous extracts of *L. cloustoni* frond were examined by Mr. K. C. Reid (Scotland), who concluded that these two chemicals could be made available to industry at a reasonable price provided the weed residue was also processed for alginate. The drying of freshly harvested *L. cloustoni* was discussed by Dr. R. G. Gardner (Scotland, with T. J. Mitchell).

At the session devoted to the use of seaweed meals in human and animal nutrition, Dr. H. C. Wood (United States) read a paper (with G. L. Seifert) on *Macrocystis pyrifera* as a source of trace elements in human nutrition, and Mr. A. A. McInnes (Scotland) stressed the importance of seaweeds as a source of trace elements for cattle, pigs, poultry and sheep. Sales of seaweed meal in the world to-day show that the claims of the seaweed producers are in fact real, although it may be difficult to prove these claims experimentally. The results of feeding *Ascophyllum*, *Laminaria* and *Alaria* meals to chicks and laying-hens were discussed by Prof. J. Høie (Norway); in general, the introduction of 3–8 per cent of seaweed meal into a basal ration which did not include any riboflavin-rich compounds led to increased growth and improved health in chicks and better-egg laying and hatching in pullets, although similar effects were obtained by the addition of yeast and grass meal. The iodine content of the eggs was considerably higher in seaweed-fed hens, and this was dealt with in greater detail in papers by I. Sunde (Norway, read by Mr. B. Larsen) and Prof. C. Romijn (Holland). The addition of 1 mgm. iodine as *Ascophyllum* meal per hen per day increased the iodine content of the egg about twenty times, while 20 mgm. per day as *Laminaria hyperborea* meal gave a 150-fold increase. The iodine is concentrated in the water-soluble fraction of the yolk and not in the protein and lipoid fractions.

The botanical session was opened by Prof. Y. Yamada (Japan) with a paper on the distribution of *Sargassum* on the coast of Japan and its neighbouring regions, in which he said that the seventy known species of *Sargassum* can be divided into two types from the distribution point of view, and most of these are utilized as fertilizer. Prof. A. A. Aleem (Egypt) described his underwater studies on the ecology of *Macrocystis pyrifera* on the coast of California by means of the Cousteau–Gagnan aqualung, by which maps and surveys of the kelp beds were made and correlated with surface observations by aerial photography; this would seem to be a very successful method of studying sublittoral ecology, and is by no means confined to seaweeds. Prof. W. E. Isaac (South Africa) reviewed the species occurring in the Saldanha–Langebaan Lagoon, off the south-west coast of South Africa, in which *Gracilaria confervoides* is cast up to the extent of about a thousand tons a year and forms the basis of a small agar industry. Miss B. T. Chiu (Hong Kong) discussed the seaweeds of economic importance in south China, where the abundant *Sargassum* species are harvested for use as fertilizer and animal feedstuff, and many brown and red algae are used in human foods, medicine and the textile industry. Variations in the standing crop of *Laminaria cloustoni* have been observed for three areas off the coast of Scotland, and the significance of these survey results was dealt with by Mr. W. D. Richardson (with F. T. Walker, Scotland); in general, there was a decrease in seaweed growth between 1949 and 1953, but 1954 showed a recovery in two out of the three areas.

Dr. A. D. de Virville (France) stressed the importance, both from a scientific and practical point of view, of having an accurate distribution map of marine plants of industrial value, and outlined a plan for the cartographical survey of the resources of the French coast; the Fucaceae, Laminariaceae, Gigartinaceae and Zostereae are represented by different colours on the map, which then shows the location of these plants with a fair degree of accuracy. The paper by Miss C. MacFarlane (Canada) on studies in the seaweed populations of economic importance in Digby Neck area, Nova Scotia, was read by Dr. E. Conway (Scotland) and illustrated with many beautiful slides; seventy-five miles of the shore of the Neck and islands support sixty thousand tons of harvestable rockweeds, chiefly *Ascophyllum nodosum*, and *Gigartina stellata* and *Laminaria* beds are also extensive although tidal and topographical conditions make for difficult harvesting on most Fundy shores. Growth control in the Fucaceae and growth rings in stipes of *Alaria esculenta* were discussed by Dr. E. M. Burrows (England) and Dr. E. Baardseth (Norway), respectively, the latter also reading two papers (by H. Printz) dealing with the phenology

and recolonization of *Ascophyllum nodosum*. During recent years reports have been received from various parts of the world that *Ascophyllum* is on the point of being exterminated due to its exploitation for seaweed meal, and this question of recuperation and recolonization aroused much interest among delegates; the best methods of harvesting this species were discussed in detail. Dr. H. Blackler (Scotland) discussed the time of reproduction and the rate of growth in certain Fucaceae, while Miss M. Naylor (England) dealt with the cytology of three British species of *Laminaria*, for which chromosome counts have been made both on the sporelings and the gametophytes. The resistance of *Gracilaria confervoides* to hydrogen sulphide was the subject of a paper by Mr. K. Stokke (Norway), who described experiments confirming the high resistance of the alga to this poison; the species was first recorded in Norway in 1935 and is frequently found in waters contaminated with hydrogen sulphide.

Many delegates contributed to the discussions following each paper, and it is hoped that the proceedings of the symposium will contain a résumé of these discussions together with the complete text of the papers presented. The meetings were held in the Norges Tekniske Høgskole, and three excursions were arranged in the Trondheimsfjord, when ample opportunity was given for studying the marine flora of the three localities. An excursion was also made to Molde and the west coast, and the delegates were able to view the coast at Hustad and to examine the littoral flora at Bud, where a delightful boat-trip was made to the archipelago of Bjørnsund.

It was unanimously agreed that similar symposia should be arranged in the future. Canada, France, Ireland and Spain were suggested as possible venues, and it was tentatively proposed to hold the third International Seaweed Symposium in Ireland in 1959 and the fourth in Spain in 1962. It was decided to appoint a standing committee to arrange the next Symposium.

E. T. Dewar

SCIENTIFIC MANAGEMENT

A NOTE in the programme of the National Conference on Science and Management arranged by the British Institute of Management and held at Harrogate during November 2–4 reads: "So fundamental are the changes with which the scientists are confronting us at the moment that many people are already talking in terms of a second industrial revolution. At the same time it is obvious that the face of Britain cannot be changed overnight. The responsibility for transferring new knowledge from the research laboratory to the production floor must rest with management. The British Institute of Management has therefore chosen as the theme of its National Conference for 1955 'The Impact of Science on Management in the Future'."

The conference embraced a wide range of subject-matter. The 'impact' of the scientist was naturally most noticeable in the field of technology, and on the purely technical side managers had the opportunity of learning about such topical matters as the new materials and processes made practicable within the past few years and the uses and limitations of radioactive isotopes in industry. Discussion, however, was by no means limited to material and practical problems of production. The economics and the 'human implications' of technical innovation each formed the subject of a separate panel debate, while a further panel discussed the function of the research association.

Papers presented by individual speakers indicated how scientific techniques could be applied to such operations as retailing and the analysis of market trends, while spokesmen for such specialities as accounting, sociology and economics each in their turn found time to wonder whether their own particular contribution could truly be described as 'scientific'. Looming behind each topic and linking together the whole conference was one important basic question: to what extent is the function of management itself based on scientific principles? For most of the managers attending, this question did not represent a new consideration. In the course of a very full programme they received added confirmation and demonstration of the means whereby the scientist can make a valuable contribution to the everyday task of management in industry, commerce and local government.

In a paper circulated to delegates but unfortunately, due to illness, not delivered in person, Prof. George C. Homans, of Harvard University, underlined the value of the general approach of the scientist. "The practical value of any science", he said, "is that by making experience subject to explicit intellectual control it speeds up the learning process and so sets intuition and judgment free to work on new ground rather than old. In something as important as management, anything that even begins to get us free of empiricism, or to set empiricism free for new advances, makes a contribution." Prof. Homans was referring in particular to the contribution of the sociologist. In a paper on "Operational Research", Sir Charles Goodeve, director of the British Iron and Steel Research Association, had some more general remarks to make about the application of the scientific method to management's task of planning for the future. "Getting rid of illusions about science and scientists", he said, "is one of the first essential steps in the whole field of the application of science, whether on the technical or the operational side of industry." Curves and diagrams of all types should be critically examined before acceptance by people other than those who produced them. "I have seen many examples", said Sir Charles, "of managers being overawed by curves. This is a more dangerous attitude than that of the opposite extreme. You should copy the approach of the scientists and disbelieve anything you are told until you can independently come to the same conclusions. A scientist always asks questions and will never believe the answers he is told. He will not accept an authoritative answer and is always demanding experimental proof of at least some reliable observations. The scientist believes that managers can make better decisions if they have the facts and an objective appreciation of the effects of the various sources of action open to them. It might pay the manager to wait for the scientist to do all this if he does not take too long over it."

That most unscientific word 'automation', receiving its due measure of attention within the theme of the conference, proved to be less alarming in its implications than might otherwise have been suspected. Under the treatment of Mr. John Diebold, who had travelled from the United States especially to speak at Harrogate, the subject appeared indeed to be concerned with the same fundamental and

systematic approach to management—in this case the management of production—as had been outlined by Sir Charles Goodeve. "Automation", said Mr. Diebold, "is a way of thinking, a way of 'looking at' as much as a way of doing. It is an attitude—a 'philosophy of production' rather than a particular technology of electronic devices. It is something as revolutionary in its way as Henry Ford's concept of the assembly line. It is a very simple fact that the most efficient use of machines has little to do with the most efficient division of human skills. Until recently, this was simply one of the paradoxes inherent in mechanization. With the introduction of the new concept and technology of self-regulating systems, it is no longer necessary to design the production processes around the limitations of human skills. It is here that we begin to reach the heart of the true meaning of automation."

John Diebold, who at the age of twenty-eight is described in the United States as 'the elder statesman of automation', proved to be highly conscious of his share of the responsibility for introducing this word into general currency. It is not, he said, a very beautiful one, but he has yet to find any satisfactory substitute for it. "For a long time", he added, "I have searched for a definition of automation that would be of use to me in an operational way. In the course of this conference I am sure we will all gain some new insights into the problem. In the meantime, I offer the following for your consideration: 'Automation is a means of analysing, organizing and controlling our production processes to achieve optimum use of all of our productive resources, mechanical and material as well as human'."

The need for a scientific use of the machines which the scientists have provided was emphasized by Dr. B. V. Bowden in a paper devoted to the electronic processing of data for management. More important than a machine's ability to do arithmetic, said Dr. Bowden, is its ability to organize its data. "How many managerial decisions", he asked, "rest on numerical criteria which may have been applied consciously or unconsciously by the executives? How many of them could be made by a machine?" Listing many successful applications of electronic computers to industry, Dr. Bowden had one very telling point to make. "We were once asked", he said, "to mechanize certain commercial calculations which had occupied five people for about three weeks every month. We found that the calculations could be done on the Manchester machine in a couple of hours; but further study showed that they could be done by hand in three hours if they were properly organized and simplified in a manner which the mathematician's analysis suggested. It is a very salutary experience", continued Dr. Bowden, "for any company which imagines that its accounting system is simple and well understood by the staff to try to programme the work so that it can be done by an accounting machine."

Besides the formulation of principles for the future, the conference was also concerned with the communication of those principles not only to present-day managers but also to those undergoing training for management. Education for management was one of the most urgent issues discussed at Harrogate, and the problems of training managers in science and scientists in management received special attention in two sectional meetings. Among those attending there was a strong appreciation of the vital need for more trained men in the future. This need was expressed very forcefully by Mr. R. Craig Wood in a paper entitled "The Influence of the Increasing Rate of Scientific Development on Future Management Requirements". "To make progress and succeed in the technological revolution", he said, "we will need more and better *human* management. We must upgrade our basic human material. There is no more exacting need for human management than in the development of the individual to new skills, higher abilities, greater responsibilities. The upgraded working force will need a higher level of management. Sheer technical brilliance will be no substitute for human leadership. . . . Mankind can enjoy the fruits of technical progress", concluded Mr. Craig Wood, "only so fast as it can learn to *manage* their production and distribution."

PSYCHOLOGY AND THE FILM

A ONE-DAY conference on the film in training and research in psychology and psychological medicine was held in University College, London, on October 22. This conference, which was attended by about a hundred and fifty people, was organized by the British Universities Film Council, a body founded in 1948 to promote the production, distribution and use of films in university teaching and research, and which has already organized conferences on the film in relation to language teaching, to the teaching of arts-faculty subjects, and to chemical engineering. Section A of the conference dealt with films in psychology and Section B with films in psychological medicine, the morning sessions being devoted to films in training and the afternoon sessions to films in research. Although papers were read, a feature of the conference was the showing of a great number of films. This led to critical discussion on the individual films, as well as providing the most practical form of demonstration of the various functions films can fulfil.

At the commencement of Section A, Mr. A. Watson spoke of the danger of biased or false presentation through films; but, as conference members remarked during discussion, this danger is not peculiar to the film medium. A film on the cerebral cortex of the monkey was shown. Dr. M. Gunther then read a paper on babies' first feeding responses, using a film made by her and part of a film by Dr. Tinbergen on the pecking responses of a newly hatched gull. A film on cats reared in darkness, a subject which is of interest in connexion with miner's nystagmus, showed the rotations and oscillations of the eyes of cats. Another film, entitled "Warning in the Dark", showed that the capacity of some blind persons to avoid obstacles is due to their sensitive reaction to reflected sounds.

The Department of Psychology of the University of Reading has given some attention to problems of film presentation. Mr. D. Bruce, of the Department, in a paper entitled "Immediate Recall of Film Material", said that the film is suitable for memory experiments, because for these experiments meaningful, and consequently 'life-like', material is desirable, and also material the presentation of which is capable of exact repetition. He showed a film, "Fidelity of Report". Mr. S. Laner, of the same Department, is engaged in comparing the effectiveness of films with other visual media, as aids to learning. In his experiments he uses two versions of a film, and these were

projected at the conference. One version portrayed the making of a paper barge with movement—in the normal film manner—and the other a series of static views at essential points in the operation. His experiments so far show the advantage of movement, and also of repeated film showings and of commentary. A coloured sound film, introduced by Dr. D. Fry, revealed movements of the tongue during speech of a surgical case whose cheek had been removed. It has been used in the teaching of students of physiology and of psychology, as well as phonetics.

Dr. D. Hill, presiding at the opening of Section B, said that little use has been made of films so far in psychological medicine teaching, and stressed again the need for specific objectives in teaching films. He asked conference members to consider whether films showing common or rare cases are the more valuable, and whether it might not be equally important to show the home as the clinical situation.

Dr. R. Mackeith introduced and provided commentary to the film "Hemispherectomy for Sturge–Weber Syndrome". This film, which was silent and coloured and the tempo of which (intentionally for teaching effectiveness) was slow, showed a child patient before and after hemispherectomy. The two films next projected were sound films, speech in them being an essential part of the portrayal; they were straightforward records of interviews of patients with a doctor: "Depressive states—1", and "Folie à deux". There was little change of point of view, and a minimum amount of expression through editing. In contrast, Dr. R. Spitz's film, "Grief", showing the condition of infants consequent on separation from their mothers, was the product of a high degree of selective editing.

In the afternoon Prof. P. Russell summarized the advantages of using films when studying behaviour. Films are permanent records; they facilitate measurement (including opportunity for deciding on appropriate measurements), the forming of hypotheses, and a complete analysis. A film "Function of Parietal Lobes" showed the behaviour of monkeys after lesions had been made; there was no loss of motor power of the monkeys, or of tactile discrimination, but impairment in learning from visual cues. Another interesting film—"Animal Studies in the Social Modification of Organically Motivated Behaviour"—showed the social behaviour of rats, in various circumstances of feeding. Dr. P. Sainsbury illustrated a paper on a method of measuring spontaneous movements by time-sampling motion pictures, by a film made in the course of research. A concluding paper on the use of the film as a thematic apperception test, by M. G. Cohen-Séat, of the Institut de Filmologie, Paris, was illustrated by some films made at that Institute.

The films shown at the conference illustrated the great variety of forms of record and of communication possible through cinematography. If the conference has led to an increased awareness of this, and therefrom perhaps of the value of research on the film itself, one useful purpose will have been served. Some of the films—in photography and matters of technical film detail—did not come up to the standards of the professional film-maker; but this can only emphasize the benefit which would result from better film-making facilities at universities and institutions where psychological films are made. The conference was well planned to show a number of ways in which the film can contribute to psychology training and research. Credit is due to the British Universities Film Council and to its representatives, Miss G. Keir and Mr. D. Bruce, who were responsible for the detailed arrangements. C. Denis Pegge

INTERNATIONAL RESEARCH IN RADIO ASTRONOMY

In an account of a General Assembly of the International Scientific Radio Union held in Sydney in 1952 (see *Nature*, 171, 628; 1953), reference was made to the fact that the Union had commenced the publication of some special reports on radio topics of international interest. During the past year, Nos. 3, 4 and 5 in this series have been published with the financial help of Unesco, and are obtainable from the General Secretary of the Union, at 42 rue des Minimes, Brussels*.

These three reports, which deal with different portions of the field of radio astronomy, have been prepared by small sub-committees of expert research scientists working in Australia, France, Great Britain, the Netherlands and the United States, assisted by various members of the Union under the general auspices of Commission V (Radio Astronomy), of which Dr. M. Laffineur is the chairman.

Report No. 3 is entitled "Discrete Sources of Extra-Terrestrial Radio Noise", and comprises a clear summary of the considerable volume of research which has been carried out, principally in Great Britain and Australia, since the inception of this field of work less than about ten years ago. The report deals in detail with the results of surveys of the distribution of sources of radiation, the effects of the ionosphere in producing scintillation and refraction, the detection of sources against background radiation and receiver noise, and the determination of their positions and angular band-widths.

The fourth and fifth reports in the series are bound in one cover. No. 4 is entitled "The Distribution of Brightness on the Solar Disk", and summarizes the progress made in this portion of radio astronomy since the publication of Report No. 1 in 1950 under the more general title of "Solar and Galactic Radio Noise". The present report (No. 4) deals with the problem of measuring the relative intensity of radio emission from different parts of the solar disk, and the results of observations carried out with receiving systems operating at centimetre, decimetre and metre wavelengths. These results are discussed in relation to a study of the physics of the Sun, which has confirmed in broad outline the conclusions drawn from optical observations concerning the solar atmosphere. The radio work has, however, arrived at the stage of providing more accurate estimates of electron temperature and density in the solar chromosphere and corona than have been available previously.

The exciting story of the prediction, and detection seven years later, of radiation from hydrogen in interstellar clouds on a wave-length of 21·1 cm. is discussed in cold scientific language in Report No. 5, entitled "Interstellar Hydrogen". A description is given of the mechanism of excitation of the hydrogen molecule, the measuring apparatus used, and the method of determ-

* International Scientific Radio Union. Special Report No. 3: Discrete Sources of Extra-Terrestrial Radio Noise. Pp. 56; 75 Belg. fr., 11*s.* 0*d.*, or 1·5 dollars. Special Reports Nos. 4 and 5: The Distribution of Radio Brightness on the Solar Disk; Interstellar Hydrogen. Pp. 72; 100 Belg. fr., 14*s.* 6*d.*, or 2 dollars. (Brussels: International Scientific Radio Union, 1954.)

ining the distribution of hydrogen in the galaxy. The significance of the observations and the deductions which may be drawn from them are briefly discussed; and the report concludes with a list of the scientific institutions engaged in research on the 21-cm. line.

All three reports contain a comprehensive, but selected, list of references to the specific portions of the field of radio astronomy to which they refer. The fact that they were prepared by small groups of international workers makes them invaluable to all who are studying or pursuing research in this subject.

R. L. SMITH-ROSE

BIOLOGY AND HUMAN AFFAIRS

CHANGES in educational thought and practice are usually so slight that they are scarcely discernible from one year to another; as time goes on they may build up into something formidable. Twenty years ago, for example, the teaching of biology in British schools was on a small scale. In many girls' schools botany was thought to be the only suitable biological subject, while in boys' schools botany was thought to be a subject suitable for girls, and little, except a smattering of 'nature study', was taught.

In 1935 the British Social Hygiene Council (now the British Social Biology Council), a voluntary organization formed originally to combat the venereal diseases, took the long view and turned to the educational service as a means of giving children rational information about the workings of their own bodies. It was expecting that actions based on this knowledge would lead to higher standards of health, and was hoping that a deeper insight into biology would endow men and women with a clearer appreciation of themselves as human beings; when associated with the understanding provided by the other life sciences, this would form the basis for better moral behaviour, particularly in relation to sex. The Council decided that its long-term objectives would best be achieved by promoting and supporting the development of biology teaching in schools. Public meetings were organized, as well as conferences, courses for teachers and summer schools. A journal, then called *Biology*, was launched, and now, under the name of *Biology and Human Affairs*, is celebrating twenty years of uninterrupted publication.

During those twenty years changes in three different directions have been accompanied by corresponding changes in the nature of the journal itself. First, there has been a remarkable increase in the amount of biology teaching in schools. To-day the subject is taught in many grammar schools, and it is becoming firmly established in secondary modern and primary schools, although in some of these there is a tendency to offer it only to boys, while girls are busy with domestic science. Secondly, there has been a marked improvement in the content of the subject-matter. It is developing into a genuine natural science, having depth as well as breadth; botany has been largely displaced by biology, a unified subject drawing its material and principles from both plants and animals.

The third direction in which progress has been marked is in the field of sex education. From its inception in 1914 until it ceased to be a semi-official body in 1942, the British Social Hygiene Council's main function was to act as a central organization for public enlightenment in relation to venereal disease. It was with this object in mind that the Council embarked on a vigorous campaign in favour of sex-education. At first it met with bitter opposition, particularly from religious bodies and official organizations, and sometimes from the schools, while those most favourably disposed towards this new development but who were least able to make their views effective were the children themselves. Bit by bit, however, the opposition was won over, and when in 1943 the Ministry of Education issued its pamphlet on "Sex-Education in Schools and Youth Organizations" the campaign might be said to have achieved its object. It would, of course, be presumptuous for the founders of *Biology* to claim credit for all these advances; they deserve their proportionate share.

To-day, *Biology and Human Affairs* appears as the journal of an organization, the British Social Biology Council, which is committed to promote and encourage the teaching of human biology as a cultural and practical subject; to preserve and strengthen the family as the basic social unit; and to encourage the dissemination of biological knowledge as a means of emphasizing the social responsibilities of individuals, the implications of population problems, the removal of conditions conducing to promiscuity, the elimination of commercialized vice, and a reduction in the incidence of social diseases, particularly the venereal diseases. The contents of its anniversary number indicate the broad catholic way in which those responsible for the production of the journal are seeking to implement the aims of its parent body. Articles include one on the adaptation of farm animals to their environment, by Dr. John Hammond; the fauna of built-up areas, by Dr. E. J. Popham; the natural history of the 'spiv', by Dr. P. D. Scott; the breeding behaviour of toads; a progress report on poliomyelitis; and the adventures and vicissitudes of a laboratory technician, by F. C. Taylor, senior laboratory steward at Eton College.

HOSPITAL IN-PATIENT STATISTICS IN ENGLAND AND WALES

AS part of the Registrar General's statistical review of England and Wales for the two years 1950–51, a "Supplement on Hospital In-Patient Statistics" has been published* which makes available a fresh selection of material from a hospital in-patient inquiry started in 1949. The chief purposes of the inquiry were to assist hospital administrators by a more detailed analysis of the diseases treated and the types of patients involved; and also to increase the information available about the general pattern of ill-health in the community obtainable from mortality and morbidity data. Since the inquiry has, up to the present, been largely experimental, it has covered only a proportion of hospitals; and, moreover, different selections of tables are presented for the several years analysed. Sufficient experience has now been gained to put the project on a more permanent and comprehensive basis.

* The Registrar General's Statistical Review of England and Wales for the two years 1950–51: Supplement on Hospital In-Patient Statistics. Pp. iv+151. (London: H.M.S.O., 1955.) 7s. 6d. net.

Attention is focused in this supplement on the patients' length of stay in hospital, and a variety of different types of analysis have been made involving various cross-classifications by hospital group, diagnosis, sex, age and social class. Admissions for childbirth and diseases of pregnancy have been excluded from the main tables; but a separate analysis of length of stay according to birth-weight is provided. There is also one appendix listing the participating hospitals with an age-and-sex distribution of discharges, and another giving the same type of distribution for patients actually in National Health Service hospitals on the night of the 1951 Census.

It is particularly gratifying to a statistician to see emphasis being laid on statistical frequency distributions as opposed to mere averages. Theoretical studies of fluctuations in waiting-lists, for example, are dependent on knowing the actual form of the distribution of length of stay. Again, variations in the latter with district, social class, the elapse of time, etc., are also of clinical importance. One curious point in connexion with the grouping of the frequency distributions is perhaps worth directing attention to. In Table 2, for example, the grouping is by single days up to 20, and then in tens up to 100, with coarser grouping in the tail. This seems quite reasonable and enables one to see the general shape of the curve at a glance. Tables 5 and 6, on the other hand, employ two different arrangements, each involving a mixture of intervals grouped in 1, 2, 3, 4, 7, 21, etc., days. Although one cannot say that this is wrong, a more uniform presentation would certainly make the tables easier to use and interpret.

It is, of course, most valuable to have this material on the distribution of length of stay, especially as it may be more comprehensive in future. At the same time, it must be pointed out that much more than this is required by administrators using hospital statistics to gauge the efficiency with which the demand for in-patient care is being met. Valid conclusions have to be based on considering several inter-related items, including bed allocation, bed occupancy, turnover interval, discharges and deaths (or admissions), and waiting lists as well as length of stay.

Norman T. J. Bailey

ROCKEFELLER FOUNDATION AWARDS

AMONG the grants recently made by the Rockefeller Foundation, New York, are the following:

Royal Institution, London, and Cavendish Laboratory, Cambridge

An award of 30,300 dollars has been made to the Davy Faraday Laboratory of the Royal Institution and one of 40,000 dollars to the University of Cambridge for the Medical Research Council's Unit in the Cavendish Laboratory, to aid the researches on proteins at these centres.

It is now more than twenty years since Prof. J. D. Bernal and Dr. D. Crowfoot announced in *Nature* that they had obtained X-ray diffraction photographs of a protein crystal. To interpret these photographs and get information about the structure of molecules which contain thousands of atoms has for long seemed a task of such complexity that one could scarcely hope for success. Quite recently, however, the most formidable obstacle has been overcome. M. F. Perutz has shown that heavy atoms or groups can be attached at definite places in the hæmoglobin molecule without disturbing the crystalline structure, and that by measuring the consequent changes in the intensity of diffraction, the phases of the reflexions can be determined and the structure computed. This opens up a vast new field for crystal analysis which is now being explored at a number of laboratories. New ways of attaching heavy groups to various parts in the molecule are being discovered, and these groups can be located. A beginning can be made in the task of mapping out the positions in the molecule of certain amino-acid residues or other groups, and eventually of linking them up by the intervening structure.

The Unit at Cambridge, under Dr. M. Perutz and Dr. J. C. Kendrew, and the group at the Davy Faraday Laboratory under my direction are working in complete collaboration on these problems, studying in particular the structures of hæmoglobin and myoglobin. Quite apart from the new insight which will certainly be gained into the part which these molecules play in living matter, the solution of the technical problem of applying X-ray analysis to such vast molecules is very thrilling indeed.

Lawrence Bragg

Chemical Crystallography Laboratory, Oxford

Over the past twenty years I have been interested in the possibility of using X-ray crystallographic methods to find the arrangement of the atoms in protein molecules and particularly in insulin. One of many possible approaches to solving this problem seems to be the crystallographic study of naturally occurring peptides such as the gramicidins and tyrocidine or oxytocin and vasopressin. These all have molecules much smaller in size than even the smallest protein molecules; some indeed are smaller than vitamin B_{12}, of which we have already found it possible to obtain the kind of information we require.

Dr. R. L. M. Synge has accordingly prepared for us a series of heavy-atom derivatives of gramicidin *S* and we are now making some progress with the detailed X-ray analysis of one group of these. We already have evidence that there may be a connexion between the way the peptide chain is folded in gramicidin *S* and the way it is folded in part of the molecule of insulin. But even if later we find that the connexion in chain configuration is less close than we at present suppose, we think that the atomic arrangement in these peptide molecules is itself of great interest and some importance. Parallel with the work on peptides, we are beginning again to examine the crystal structure of insulin in the light of Dr. Sanger's evidence of its chemical structure.

The present grant from the Rockefeller Foundation (£3,000, during a three-year period) is the renewal of a grant made to me over a number of years for research assistance in connexion with these problems.

Dorothy Crowfoot Hodgkin

Department of Chemical Pathology, St. Mary's Hospital Medical School, London

A grant of £4,600 has been made to the University of London for the purchase of special equipment such as a 'Spinco' preparative ultracentrifuge and an electrophoresis apparatus by the Department of Chemical Pathology at St. Mary's Hospital Medical

School. This Department has only been created this year, and I am the first holder of the chair. My recent interests have centred on the chemistry and metabolism of proteins and the biogenesis of porphyrins, and it is expected that the work of the new Department will largely proceed along the lines mentioned. In the protein field, studies on the whole animal with the aid of isotopically labelled amino-acids will be supplemented by investigations on *in vitro* systems, particularly relevant enzymes. Of special concern to the Department will be the proteins of connective tissue, and in this connexion the synthesis of collagen will receive close attention.

In the porphyrin field the main pathway of synthesis seems reasonably well established; but the enzymes responsible for the various steps are still largely unknown, and further research in this field is likely to yield interesting results.

A. NEUBERGER

Department of Zoology, University College, London

The grant of £2,700 made to me is for the purchase of a single piece of apparatus, namely, a 'Spinco' preparative vacuum ultracentrifuge, and it will be used for the preparation and analysis of various tissue fractions in connexion with the work of R. E. Billingham, L. Brent and myself on the mechanism of transplantation immunity. P. B. MEDAWAR

RADIOLYSIS OF LIQUID *n*-HEXANE AND SOLUTIONS OF ANTHRACENE IN *n*-HEXANE

By DR. F. H. KRENZ

Department of Natural Philosophy, The University, Edinburgh

A STUDY has been made in this laboratory of the radiolysis in vacuum of pure, liquid *n*-hexane and of solutions of anthracene in hexane by γ-rays from a cobalt-60 source. The principal products of the radiolysis of the hexane were hydrogen, methane, ethane and an unsaturated hydrocarbon with approximately the same volatility as *n*-hexane. C_3- and C_4-hydrocarbons were also detected, but in amounts which were negligible compared with those of the principal products. A C_6 fraction was never satisfactorily separated from hexane, but did not appear to contain any important product.

Hydrogen, methane, ethane and the unsaturated liquid hydrocarbon were formed in amounts which were directly proportional to the energy absorbed from the γ-rays up to the highest concentrations of products measured (*c.* 10^{-4} *M*). The yields, *G*, in terms of the molecules of products per 100 eV. of γ-ray energy absorbed by the hexane (determined by ferrous sulphate actinometry, using $G_{Fe^{3+}} = 15{\cdot}5$) were:

$G_{H_2} = 4{\cdot}89 \pm 0{\cdot}2$ $\quad G_{C=C} = 4 \pm 2$
$G_{CH_4} = 0{\cdot}41 \pm 0{\cdot}1$ $\quad G_{C_2H_6} = 0{\cdot}69 \pm 0{\cdot}1$

The radiolysis in vacuum of solutions of anthracene in hexane showed that anthracene in concentrations up to 10^{-3} *M* had no measurable effect upon the yields of hydrogen, methane or ethane, but caused a diminution in the yield of unsaturated products. $G_{C=C}$ decreased with increasing anthracene concentration toward a minimum value of approximately 2. The radiolysis of the solutions was accompanied by 'fading' of the anthracene absorption spectrum. The bands between 300 and 380 mμ gradually disappeared, and were replaced by a new spectrum between 200 and 280 mμ, superimposed upon the very intense anthracene band at 256 mμ. The new spectrum closely resembled that of dianthracene (Weiss, J., private communication; I am indebted to Dr. Weiss for the absorption spectrum of dianthracene in ethanol). G_{-A}, the number of anthracene molecules disappearing per 100 eV. of γ-ray energy absorbed by the hexane, was described within the experimental error by the function:

$$G_{-A} = 3{\cdot}6 \left\{ \frac{3 \times 10^3 M}{1 + 3 \times 10^3 M} \right\}$$

where *M* is the concentration of anthracene in moles per litre.

The results above are explained by a simple mechanism resembling that which has been established for the mercury-photosensitized photolysis of paraffin hydrocarbons in the gas phase[1]. The principal primary step in the radiolysis of hexane is considered to be

$$RH^* \rightarrow R^{\cdot} + H^{\cdot} \qquad (1)$$

RH^* represents an electronically excited molecule of hexane resulting from primary absorption processes[2], $R^{\cdot}$ a hexyl radical and $H^{\cdot}$ a hydrogen atom formed by the rupture of a C—H bond in hexane. The rupture may impart considerable kinetic energy to the fragments, particularly to $H^{\cdot}$, which probably reacts immediately with the surrounding hexane:

$$H^{\cdot} + RH \rightarrow H_2 + R^{\cdot} \qquad (2)$$

The hexyl radical must disappear, in the absence of competing reactions, by

$$R^{\cdot} + R^{\cdot} \rightarrow R_2 \qquad (3a)$$

or

$$R^{\cdot} + R^{\cdot} \rightarrow RH + R_x \qquad (3b)$$

R_2 is the dimer, dodecane, and R_x is an unsaturated compound formed by the disproportionation of two hexyl radicals, that is, it is one of several possible isomeric hexenes.

The relatively small amounts of methane and ethane found among the products may result from (*a*) the primary rupture of a C—C bond in *RH*, (*b*) $H^{\cdot}$ atom 'cracking' of hexane[3] as an alternative to reaction (2), or (*c*) dissociation of an excited radical produced in the primary step (1). The methyl or ethyl radicals so formed probably undergo reactions analogous to (2), forming methane and ethane respectively[4]. The reason for the relative unimportance of processes of this type is not apparent.

In solutions of anthracene, reactions (3*a*) and (3*b*) must compete with the following reaction:

$$R^{\cdot} + A \rightarrow RA^{\cdot} \qquad (4)$$

Here A represents a molecule of anthracene, and $RA^{\cdot}$ is a new free radical resulting from the addition of $R^{\cdot}$ to A, probably at the 9- or 10-position. $RA^{\cdot}$ may react with a second $R^{\cdot}$ to form RAR, or may form a dimer analogous to R_2, namely, $RAAR$. In either case a stable product is formed having an electronic structure similar to that of dianthracene.

The results summarized above are in substantial agreement with the results of earlier studies of the radiolysis of paraffin hydrocarbons[5], and the theory successfully describes the earlier results. The yield, G_R, of free hexyl radicals given by the theory is

$$G_R = 2\,G_{H_2} + G_{CH_4} + G_{C_2H_6} = 10{\cdot}9$$

On the same basis, the yield of radicals of all kinds (excluding H· atoms) is at least 12. These values are in agreement with values of G_R ranging from 9·9 to 14·3 recently found by Magat and co-workers[6] for *n*-heptane, *n*-octane and *cyclo*hexane, using an independent method of measurement.

More recently, Schuler and Allen[7] have noted that the yield, G_{H_2}, of hydrogen from liquid *cyclo*hexane decomposed by energetic radiation was independent of the linear ion density of the radiation. Such an effect is explained in terms of reactions (1) and (2) above, since the separation between successive ionizations (or excitations) would have to be of molecular dimensions before recombination of atoms could compete effectively with reaction (2).

A complete account of the present work has been submitted for publication in the *Canadian Journal of Chemistry*. I am grateful to Prof. N. Feather for support and encouragement and to Drs. N. Miller and R. A. Back for much help and advice in the course of the work.

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NUCLEUS AND CYTOPLASM IN CELLULAR INHERITANCE

By Prof. J. F. DANIELLI, Dr. I. J. LORCH, Dr. M. J. ORD and Miss E. G. WILSON
Department of Zoology, King's College, London, W.C.2

THE relative importance of nucleus and cytoplasm in cellular inheritance is uncertain. We have studied this problem by transferring nuclei of one species of *Amoeba* into the cytoplasm of another species. In such heterotransfers the resultant animal usually lives for up to a month, may undergo a number of divisions, and very occasionally will give rise to a clone of animals of viability and vigour comparable with the parent animals. We have previously reported on the characters of heterotransfers for the first month after the transfer operation. In this period the characters follow the cytoplasmic type closely, although some influence of the nuclear species can be detected[1]. The present report is concerned with a study, over a period of six years, of a heterotransfer clone which originated from the transfer of an *Amoeba proteus* nucleus into the cytoplasm of an *Amoeba discoides*. This clone is known as $\overrightarrow{P_nD_c}(1)$. Similar studies are in progress with other heterotransfer clones, but are not sufficiently advanced to warrant present reporting.

The characters studied fall into three groups: (1) observations made on individuals taken from mass cultures of $\overrightarrow{P_nD_c}(1)$; (2) observations made by transferring nuclei from $\overrightarrow{P_nD_c}(1)$ to cytoplasms of clones similar to the parent clones, and by replacing the nucleus in $\overrightarrow{P_nD_c}(1)$ amœbæ with a *proteus* or *discoides* nucleus from clones similar to the parent clones; (3) observations on antigens.

Quantitative measurements of the following characters were made on individuals taken at random from mass cultures: shape when moving; average nuclear diameter; frequency distribution of nuclear diameters; division rate. As shown in Table 1, the shape of the animals when moving is intermediate between the shapes of the two parent species. On the other hand, the nuclear diameter, the frequency distribution of nuclear diameters and the rate of division are very much more like those of the cytoplasmic parent than like the nuclear parent. The shape when moving and the two nuclear characters were measured about three months after this clone was first obtained, in 1949, and have been re-measured at intervals of a year or less. Over this period of six years there has been no change in these characters, outside the limits of experimental error.

When the nuclei from individuals of $\overrightarrow{P_nD}$ (1) are back-transferred to *proteus* cytoplasm (P_c) or *discoides* cytoplasm (D_c), it is possible to make quantitative observations of the frequency of reactivation as well as of the other characters. When an *Amoeba* is enucleated it tends to round up and become covered with small short blunt pseudopodia. When renucleated successfully the *Amoeba* resumes amœboid movement, with a concomitant change of shape: it is this return to normality which is termed reactivation. Nuclei from $\overrightarrow{P_nD_c}(1)$ reactivated P_c and D_c equally well. On the other hand, when the frequency of divisions and the probability of clone formations were observed, the behaviour of these individuals after reactivation was more like that which would have been found after renucleation with D_n than with P_n. Thus, after a long sojourn in *discoides* cytoplasm, *proteus* nuclei are modified so as to resemble *discoides* nuclei in some respects. When the cytoplasm of individuals from the clone $\overrightarrow{P_nD_c}(1)$ was renucleated with P_n or D_n, the cytoplasm behaved more like *discoides* than

Table 1

In this table the various characters of the culture $\overrightarrow{P_nD_c(1)}$ are compared with the same characters in the parent species P_nP_c and D_nD_c

Character	Like *D*	Like *P*	Balanced
A. Measurements on $\overrightarrow{P_nD_c(1)}$			
Division rate	+		
Shape			+
Nuclear diameter	+		
Distribution of nuclear sizes	+		
B. Results of back transfers			
Nuclei from $\overrightarrow{P_nD_c(1)}$ to P_c or D_c			
Reactivation			+
Frequency of divisions	+		
Clone formation	(+)		
Nuclei from *P* or *D* to cytoplasm from $\overrightarrow{P_nD_c(1)}$			
Reactivation			+
Frequency of divisions	+		
Clone formation	(+)		
C. Reactions to antisera			
Antisera to *proteus*			
Toxicity	+		
Shape		+	
Division rate		+	
Antisera to *discoides*			
Toxicity		+	
Shape		+	
Division		+	

like *proteus* cytoplasm. Although this was so, there was a considerable difference between cytoplasm from $\overrightarrow{P_nD_c(1)}$ and cytoplasm from the original *discoides* clone, especially so far as frequency of clone formation was concerned.

The general conclusions which may be drawn from the ten morphological and physiological characters reported in Table 1 are: (*a*) that after six years the cytoplasmic influence on all these characters is always as strong as the nuclear influence, and for most characters the cytoplasmic influence is very much more pronounced, and (*b*) both nucleus and cytoplasm have changed to a significant degree. The degree to which these changes in nucleus and in cytoplasm are reversible has yet to be investigated.

Over the past eighteen months we have studied the reactions of $\overrightarrow{P_nD_c(1)}$ to cytolytic antisera prepared in rabbits. It is usually supposed that cytolytic antisera cause specific cytolysis by combination of antibody with antigen in the plasma membrane. Antisera prepared to *discoides* and *proteus*, respectively, are specific for the species to which they are prepared. When an *Amoeba* is placed in a dilute solution of a toxic antiserum it takes up a shape characteristic of the amoeba species, becomes immobilized and in sufficiently concentrated antibody will ultimately die. In lower concentrations of antibody the animal may recover, feed and divide. In Table 1 is recorded the behaviour of $\overrightarrow{P_nD_c(1)}$ in antisera prepared from *A. proteus* and from *A. discoides*. We have measured the toxicity (determined by the proportion of animals killed after twenty-four hours exposure to dilute antiserum), the shape of animals in antiserum and rate of division after recovery in antiserum. In five out of six characters studied with antisera, the influence of the nuclear species is far greater than that of the cytoplasmic species. Thus the surface antigens, that is, some of the macromolecules making up the surface of an amœba, have characters at the macromolecular level which are mainly determined by the nuclei.

The general outcome of this study of sixteen characters is that, whereas there is a strong predominance of cytoplasmic influence determining morphological and physiological characters, there is an equally strong predominance of nuclear influence determining antigenic, that is, macromolecular, characters. From the time of the original heterotransfer to the most recent measurements summarized in Table 1, the clone $\overrightarrow{P_nD_c(1)}$ had undergone not less than five hundred consecutive cell divisions, so that the molecules present in the original heterotransfer have been diluted by a factor of the order of 2^{500}. On the average the amoebae which now constitute this clone cannot contain even one molecule of the proteins, nucleic acids or polysaccharides which were present in the original nucleus and cytoplasm at the time of heterotransfer. Consequently, it is impossible to explain even a modest degree of persistence, at the present time, of either nuclear or cytoplasmic traits by the passive carry-over of macromolecules from the original nucleus and cytoplasm. All persistent characteristics which are now present in this clone must be present as a result of often repeated duplication.

We cannot here set out the numerous alternative hypotheses with which the facts reported above are compatible. The hypothesis which appears to us to be the most interesting to investigate is that the nucleus determines the specific characters of the macromolecules which are present in a differentiated cell, whereas the organization of these macromolecules into functional units depends to a very marked degree upon cytoplasmic inheritance. The nucleus may exert its influence in a variety of ways: for example, the actual synthesis of antigenic macromolecules may be nuclear, or the nucleus may supply to the cytoplasm complex enzymic units which carry out syntheses of macromolecules in the cytoplasm, or the nucleus may provide some other active unit, possibly pentose nucleic acid, which can leave a nuclear imprint upon the products of cytoplasmic synthesis, etc. This hypothesis, like most other hypotheses which might be advanced to account for the distribution of nuclear and cytoplasmic inheritance, does not account directly for the fact that nucleus and cytoplasm interact and change one another.

The amoebae used in these studies have been kept, so far as possible, in constant environmental conditions. We have evidence that discontinuous changes may take place in some of the characters we have studied as a result of variation in environmental conditions.

We must add that undue importance should not be attached to observations on one heterotransfer clone. Most heterotransfers do not become stabilized and give rise to clones, and despite much painstaking study we cannot yet define the circumstances which decide whether a heterotransfer will become stable. A variety of other heterotransfer clones must be studied before we can tell whether the results summarized in Table 1 are typical. Additional heterotransfer clones are now being investigated; but it will be a number of years before the complete picture is established.

Note added in proof. Serological studies of a second interspecific clone have now been obtained which agree closely with those reported on $\overrightarrow{P_nD_c(1)}$.

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LETTERS TO THE EDITORS

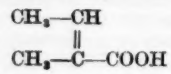
The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Configurations of Tiglic and Angelic Acids: an X-Ray Determination

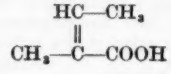
Prof. S. Stenhagen recently directed our attention to the need for a direct determination of the configurations of tiglic and angelic acids, because in recent synthetic work on certain 2-methyl-alkenoic acids the assignment of geometrical configuration has been based primarily on the correlation of their spectral data with those of the simplest acids of the series, tiglic and angelic.

Tiglic acid has generally been assigned the *trans*-configuration (*cis*-methyl) mainly from a study of the rates of esterification of tiglic and angelic acids under similar conditions[1], and from a comparison of the physical properties of these acids with the *cis*- and *trans*-crotonic acids[2]. This evidence is certainly indirect; but more conclusive chemical evidence has recently been obtained by Dreiding and Pratt[3] from a study of the carboxylation of *cis*- and *trans*-2-butenyl lithium, a reaction which is considered to afford a stereospecific synthesis of tiglic and of angelic acid.

Although the combination of all the above evidence may be regarded as conclusive, we still felt that it was desirable to attempt a completely direct determination of the structures of these acids by the method of X-ray crystal analysis. This has now been carried out. In the case of tiglic acid, all the atomic positions have been ascertained with considerable accuracy (see Fig. 1) and the results establish the *trans*-configuration, with the double bond in the α–β position of the butenic acid chain:



Our work on angelic acid is not yet complete; but the results so far obtained are sufficient to show quite conclusively that this acid has the expected *cis*-configuration:



Crystals of tiglic acid are triclinic, with $a = 7{\cdot}70$, $b = 5{\cdot}23$, $c = 7{\cdot}42$ A. (all $\pm 0{\cdot}02$ A.), $\alpha = 96°$, $\beta = 87{\cdot}7°$, $\gamma = 74{\cdot}5°$ (all $\pm 1°$). The volume of the unit cell is 286 A.^{3} and it contains two molecules (density observed, 1·163, calculated 1·162). The space group $P\bar{1}$ has been assumed, with the centre of inversion between the carboxyl groups of two molecules hydrogen bonded to form a symmetrical dimer. On the basis of these assumptions, the problem was attacked by the molecular Fourier transform method, with projections along the short *b*-axis. The transform evaluated for the *cis*-molecular structure could not be fitted to the weighted reciprocal lattice net; but with the *trans*-structure an excellent fit was soon obtained. The phase constants of the (*h*0*l*) structure factors obtained by this process enabled an electron-density projection to be evaluated. After several refinement processes, the map shown in Fig. 1 was obtained, with all the carbon and oxygen atoms clearly resolved.

This projection is consistent with a coplanar structure and with bond-lengths and valency-angles

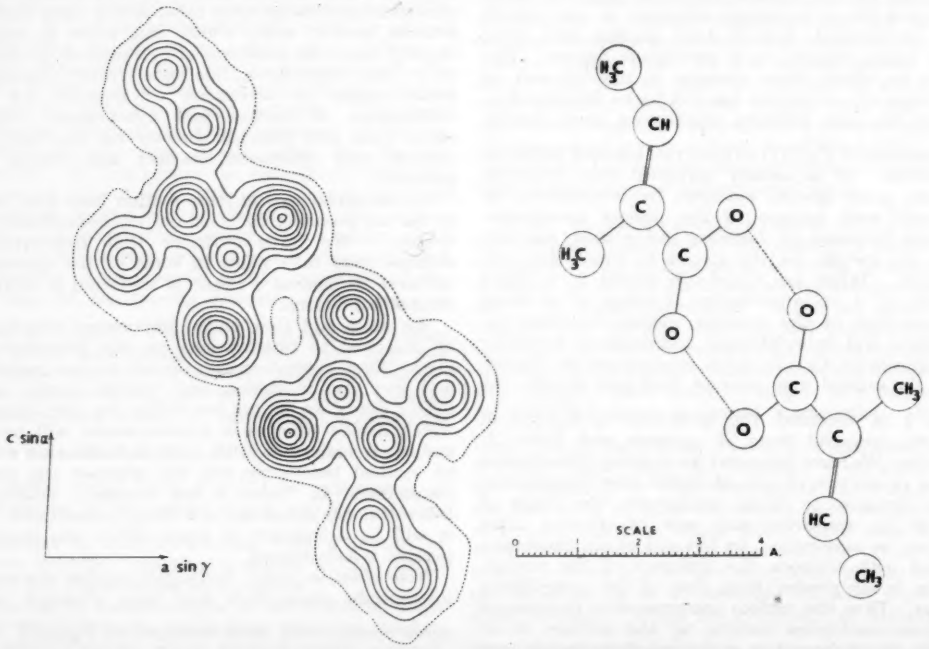


Fig. 1. Electron density projection of tiglic acid dimer

of the expected magnitudes, except that there is some evidence of repulsion between the methyl groups attached to the α- and β-positions. The β-methyl groups at the extreme ends of the picture appear to be somewhat displaced in position. Whether the whole structure is accurately coplanar or not must await a more accurate evaluation of the third co-ordinates of the atoms, which are perpendicular to this projection plane. In the meantime, it may be noted that difference syntheses based on this projection indicate clearly the number of hydrogen atoms attached to each carbon and thus show that the double bond is in the α–β position and not in the side-chain.

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Sept. 21.

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The Free Amino-Groups of Soluble Feather Keratin

Feather keratin can be made soluble by extraction with urea and reducing agents or by oxidation with performic acid, and it has been shown that the resulting solutions contain particles with a small distribution of weight and charge and a molecular weight of 10,000 [1,2]. Rougvie[3] oxidized feather keratin directly with peracetic acid and similarly found the soluble particles to have a molecular weight of 10,000. He also made the important observation that fibres reconstituted from the oxidized material gave X-ray diffraction patterns with much of the detail of those of the original feather.

This communication is concerned with the results of an end-group analysis of oxidized feather keratin (cysteic acid – keratin) prepared according to the method already described[2]. The interpretation of the end-group analysis of other keratins has been difficult because the molecular weight of the reacting material has not been known. We do not have this complication in the case of feather keratin.

After reaction of cysteic acid – keratin with fluorodinitrobenzene (24 hr. in 50 per cent ethanol and 1 per cent sodium bicarbonate) and subsequent hydrolysis in 5·8 *N* or 12 *N* hydrochloric acid, the dinitrophenyl derivatives of aspartic acid, serine, threonine, glutamic acid, glycine, alanine and valine can be detected; ε-dinitrophenyl lysine is also present. However, the total amount of α-dinitrophenyl amino-acids corresponds to only 0·1 equivalents/mole of protein, and similarly the concentration of dinitrophenyl lysine is 0·1–0·15 mole/mole protein. Coupling of cysteic acid – keratin with fluorodinitrobenzene, in 2 *M* guanidine in 50 per cent ethanol, or in aqueous solutions at *p*H 11·5, gives a similar product to this. Traces of dinitrophenyl amino-acids can also be found in the ether extract of the acidified dinitrophenyl-keratin before hydrolysis, and it is possible that the few end-groups result from degradation during coupling.

Cysteic acid – keratin, treated with cation and anion exchange resins to remove small ions, combines with less than 0·2 equivalent hydroxyl ion/mole protein between *p*H 6 and 8·5. Between *p*H 8·5 and 10·5, 0·2 equivalents of OH^- ion are bound by each mole of protein. Hence few ε-amino-groups of lysine, α-amino-groups or imino-groups in each protein molecule are available to the hydroxyl ion.

The molecular weight of cysteic acid – keratin is known unambiguously and the gross composition is consistent with the absence of a non-protein prosthetic group, so the failure of the α-amino-groups to react with hydroxyl ion or with fluorodinitrobenzene is evidence that the protein has a cyclic structure.

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Electron Microscopic Observation of Monolayers of Synthetic Linear Polymers

When monolayers of some synthetic linear polymers at air/water interfaces are compressed to less than a certain area, bright streaks can be observed under dark-field illumination[1]. Subsequent compression gives rise to tiny visible striations running across the width of the trough and finally produces fibrous threads which can be picked up from the water surface. Since little is known about the structure of these heterogeneities, we have carried out an electron microscopic examination of spread films of synthetic polymers, and obtained, especially in the case of nylon, interesting pictures exhibiting the structure of the spread films.

A sample of 6-nylon (poly-ε-capramide, *D.P.*153) was spread from its mixed solution in benzene–phenol (3/1 v/v) on the surface of distilled water in a Langmuir trough. The uncompressed and compressed films were transferred to a collodion support by using a lifted film technique[2] for building up films on a slide. They were then shadow-cast with chromium at an angle of 12° to the surface and examined in a Hitachi *HS*-II type electron microscope. Micrographs are shown in Figs. 1 and 2. A blank water sample, which was transferred from the trough to a collodion support, is shown in Fig. 1,*a*.

When 6-nylon films were initially spread at an area of 80 A.^{2}/monomeric unit, unspread material was seen in the form of winding microfibrils (Fig. 1,*b*). The mean microfibrillar thickness was estimated to be 30 A. from the width of the shadow. The bare portions may contain film molecules that are less densely packed. When compressed to 30 A.^{2}/monomeric unit, the film produced a large number of microfibrils oriented approximately at right angles to the direction of compression and linked together to form a network (Fig. 1,*c*). This network may account for the elasticity which had been found with these films[3]. Further compression to 2 A.^{2}/monomeric unit brought about visible striations on the films. The film structure in this region exhibited an

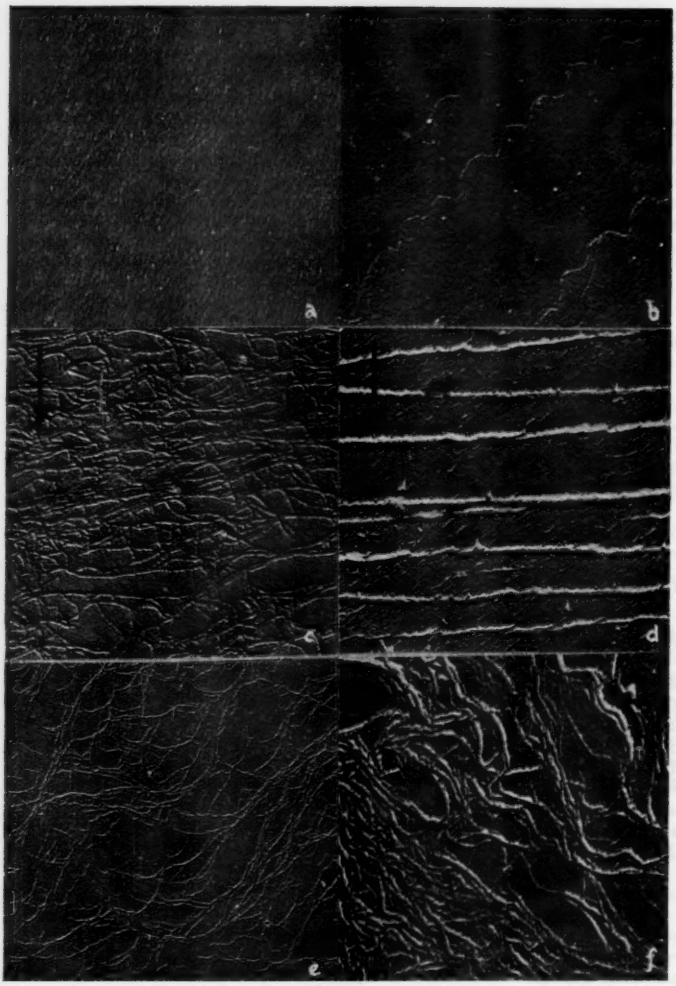

Fig. 1. Electron micrographs of monolayers of 6-nylon

(*a*) Blank, no film, magnification 13,500; (*b*) uncompressed films at 80 A.², magnification 13,500; (*c*) compressed films at 30 A.², magnification 13,500; (*d*) compressed films at 2 A.² (after collapse), magnification 8,100; (*e*) uncompressed films at 18 A.², magnification 10,700; (*f*) uncompressed films of low molecular fraction at 18 A.², magnification 10,700. Arrows indicate the direction of compression

array of parallel microfibrils oriented at right angles to the direction of compression (Fig. 1,*d*).

Uncompressed films initially spread at a small area, for example, 18 A.²/monomeric unit, gave winding microfibrils which had no sign of orientation (Fig. 1,*e*).

From the above results, it is evident that compression of the film gives rise to the formation of a large number of microfibrils which adopt an orientation at right angles to the direction of compression. It is to be noted that the mean size of the microfibrils remained almost unchanged during compression.

The effect of the degree of polymerization on the structure of surface films is also revealed by the electron microscope. In Fig. 1,*f* is shown the structure of uncompressed films of 6-nylon (*D.P.*8) spread at an area of 18 A.²/monomeric unit. Comparison of Figs. 1,*e* and 1,*f* shows that the fraction of low molecular weight produced thicker microfibrils than the fraction of high molecular weight.

Similar investigations have also been made with other crystalline polymers, for example, cellulose acetate and polyvinyl alcohol. Secondary products of cellulose acetate (Celanese No. 3, wood-pulp source) were dissolved in acetone, and the hazy solution thus obtained was spread on distilled water. The uncompressed films, initially spread at an area of 70 A.²/monomeric unit, contained a large number of granules, the mean size of which was estimated to be about 100 A., but no fibrils (Fig. 2,*a*). These granules decreased in number considerably when the acetone solution was spread after centrifugation, so it is possible that they might be partly responsible for the haze in the solution[4]. Another sample of cellulose acetate, produced from cotton linters (Celanese No. 1), also gave similar granules. When these films were compressed to less than 10 A.²/monomeric unit, thin microfibrils appeared with an orientation at right angles to the direction of compression (Fig. 2,*b*). Compressed films of polyvinyl alcohol also gave a similar fibrillar picture.

On the other hand, amorphous polymers, for example, polyvinyl acetate and polymethylmethacrylate, even when their films were compressed to a very small area, exhibited folds only, without any regular fibrillar substructure.

Fig. 2. Electron micrographs of monolayers of cellulose acetate

(*a*) Uncompressed films at 70 A.², magnification 13,500; (*b*) compressed films at 10 A.², magnification 10,700. Arrow indicates the direction of compression

Full details of this work will be published elsewhere.

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Negative Thixotropy of Aqueous Solutions of Polymethacrylic Acid

SUFFICIENTLY concentrated aqueous solutions of polymethacrylic acid (about 8–15 per cent, depending on the degree of polymerization) form clear stiff gels at room temperature. At somewhat lower concentration, such systems are sols. On heating, these sols can be converted into gels; on cooling, the gelation is completely reversible, the gels reverting to sols which reach their original consistency after about an hour.

A remarkable characteristic of these sols is their reaction to shear. A several hundred-fold increase in consistency is easily induced by stirring or shaking. For example, a 5 per cent solution of polymethacrylic acid of degree of polymerization 10,000 shows a 350-fold increase in apparent viscosity (from 5 poise to 1,750 poise) after subjection, for about one minute, to a rate of shear of 10 sec.$^{-1}$. More concentrated sols (5–10 per cent) will actually set to firm gels while being stirred with a glass rod or simply when the bottle in which they are contained is shaken[1]. The transformations are completely reversible, and the systems reach the original state about an hour after stirring has ceased. Increase in the degree of polymerization and higher temperature enhance the effect. This behaviour represents, to our knowledge, by far the most pronounced instance of 'negative' thixotropy yet described in the literature[2].

Negative thixotropy is here understood to denote a reversible isothermal increase in consistency during mechanical treatment. In negatively thixotropic systems, the field of flow displaces the equilibrium of the system from its state as a sol, at rest, to a gel state of higher free-energy content which, on standing, spontaneously reverts to the sol state. Negatively thixotropic behaviour, therefore, is the exact opposite of normal thixotropic behaviour, in which the state of lower free energy, to which the system reverts spontaneously upon cessation of mechanical agitation, is the gel state. Negative thixotropy should also be distinguished from the well-known phenomenon of work hardening, in which shearing only enhances the rate of the spontaneous process of crystallization, and from the phenomenon of dilatancy, described by Osborne Reynolds, which is due to a special rearrangement of rigid particles in a suspension.

The phenomenon of negative thixotropy is rarely encountered. Even among those water-soluble polymers such as polyacrylic acid and polyacrylic and polymethacrylic amide, the structure of which is closely related to that of polymethacrylic acid, we failed to find signs of such behaviour. In fact, most aqueous polymeric systems, for example, gelatine[3] and methylcellulose solutions[4], show normal thixotropy.

In our opinion, negative thixotropy in polymethacrylic acid systems is probably due to the fact that, *a priori*, more intermolecular bonds are likely to be formed in a field of flow than in a system at rest. During flow, the collision frequency between groups of different polymer molecules increases, permitting, other things being equal, the formation of a network, and the consequent appearance of gel behaviour. Since in a concentrated polymer solution we expect an equilibrium between intra- and inter-molecular bonding, the effect of the field of flow will be to shift this equilibrium towards a greater amount of cross-linking by intermolecular bonds.

The field of flow, however, acts in two ways. It not only builds up structure, as described above, but it also breaks intermolecular bonds that are insufficiently strong. Indeed, in the usual thixotropic systems, this second effect predominates. Apparently it is only in solutions of polymethacrylic acid, at the rates of shear investigated, that the first effect so largely predominates.

The intermolecular cross-links in polymethacrylic acid solutions seem to be hydrogen bonds between carboxyl groups on neighbouring chains. These bonds are indeed relatively strong, but their strength cannot be the only factor accounting for the negative thixotropy. As noted above, other substances strongly hydrogen-bonded, such as the polyamides and polyacrylic acid, do not form sols with negative thixotropy. Additional factors such as, for example, the relative stiffness of the polymethacrylic acid molecule, which may permit local, crystallite-like accumulations of hydrogen bonds, probably play a decisive part.

Despite their relative strength, the hydrogen bonds are breaking and re-forming at a considerable rate; when mechanical agitation ceases, the initial state, with a higher degree of intramolecular bonding, is gradually approached. The gel structure thus breaks up and the original sol is re-formed.

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Photo-elastic Dispersion in Cubic Crystals

CRYSTALS of classes T_d, 0 and 0_h are characterized by the strain-optical coefficients p_{11}, p_{12} and p_{44}, whereas those of the classes T and T_h have an additional coefficient[1] p_{13}. Using standard methods described elsewhere[2,3], the p values at three wavelengths of light for a few cubic crystals have been determined and are given in Table 1. In Table 2 the values obtained by me for some optical glasses are entered.

It is interesting to note that: (1) cubic crystals, in general, show photo-elastic dispersion; (2) the values of p_{11} and p_{12} in potassium chloride and bromide increase with increasing wave-length, whereas in all other crystals their behaviour is opposite. The dis-

Table 1

Substance	λ_1	p_{11} / λ_2	λ_3	λ_1	p_{12} / λ_2	λ_3	λ_1	p_{13} / λ_2	λ_3	λ_1	p_{44} / λ_2	λ_3
Potassium bromide	0·212	0·208	0·194	0·165	0·162	0·151	—	—	—	0·022	0·022	0·024
Potassium chloride	0·215	0·211	0·182	0·159	0·156	0·134	—	—	—	0·024	0·024	0·026
Lithium fluoride	0·020	0·020	0·020	0·130	0·130	0·130	—	—	—	0·045	0·051	0·068
Lead nitrate	0·309	0·348	0·398	0·608	0·666	0·742	0·476	0·537	0·613	0·039	0·045	0·070
Ammonium alum	0·378	0·403	0·418	0·465	0·496	0·514	0·454	0·479	0·497	0·009	0·009	0·011
Potassium alum	0·250	0·259	0·268	0·330	0·342	0·345	0·321	0·332	0·342	0·005	0·005	0·006

λ_1 = 5893 A. λ_2 = 5461 A. λ_3 = 4358 A.

Table 2

Glass	λ_1	p_{11} / λ_2	λ_3	λ_1	p_{12} / λ_2	λ_3
I	0·214	0·243	—	0·371	0·374	—
II	0·223	0·225	0·249	0·331	0·334	0·369
III	0·126	0·127	0·129	0·227	0·229	0·234
IV	0·173	0·177	0·180	0·238	0·244	0·248
V	0·154	0·156	0·159	0·210	0·223	0·227

λ_1 = 5893 A. λ_2 = 5461 A. λ_3 = 4358 A.

persion for these two coefficients in lithium fluoride is negligible[3]. The direction of variation in p_{44} is the same in all crystals. The magnitude of dispersion of this coefficient is usually of the order found in glasses, except in lithium fluoride and lead nitrate, where it is large, being 60 to 80 per cent.

I thank Prof. S. Bhagavantam, under whose direction this work was undertaken.

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Site of Inhibition of Trypsin by Diethyl *p*-Nitrophenylphosphonate

The inhibition of proteolytic enzymes by organophosphorus esters has been the subject of intensive study in recent years[1]. Thus, the reaction of trypsin with di*iso*propyl fluorophosphonate[2] or diethyl *p*-nitrophenylphosphonate[3] has been shown to be accompanied by a loss in its esterase and proteolytic activity. Still unanswered, however, is the question whether these inhibitors combine with trypsin at the site responsible for enzymatic activity, or at another site, which, because of its strategic location, may interfere sterically with the enzymatic centre.

We recently reported[4] that trypsin remains enzymatically active in high concentrations of urea. At the same time an increase in the solubility of the enzyme in trichloracetic acid was noted which suggested that perhaps some profound change in the structural configuration of the molecule may have occurred. In this event, some alteration in the normal spatial relationship of active centres that may be present might likewise be expected. The results reported here indicate that diethyl *p*-nitrophenylphosphonate does in fact react with trypsin treated with urea at a site which can be distinguished from the site responsible for proteolytic activity.

The trypsin used in this study was a twice-crystallized product (Worthington Biochemical Corp., Freehold, N.J.) which was freed of salt by dialysis against 0·001 *N* hydrochloric acid, followed by lyophilization. Diethyl *p*-nitrophenylphosphonate was kindly provided by Dr. William Summerson, of the Army Medical Center, Md.

The experimental procedure was as follows: 1 mgm of trypsin was dissolved in 4 ml. of 0·05 *M* borate buffer, *p*H 7·6, containing 8·3 *M* urea, and immediately treated with 1 ml. of 6×10^{-3} *M* diethyl *p*-nitrophenylphosphonate in *iso*propanol (one hundred-fold excess on a molar basis). The mixture was allowed to stand at 25° C. A similar system from which urea had been omitted contained 0·02 *M* calcium chloride to minimize self-digestion of the enzyme. 1 ml. of *iso*propanol replaced the diethyl *p*-nitrophenylphosphonate solution in controls set up to measure losses in activity not attributable to diethyl *p*-nitrophenylphosphonate. Enzyme-free controls were likewise necessary to correct for the spontaneous hydrolysis of the diethyl *p*-nitrophenylphosphonate during the course of the reaction. At various intervals of time, the liberation of *p*-nitrophenol, the product of the reaction between trypsin and diethyl *p*-nitrophenylphosphonate, was measured by the method of Hartley and Kilby[5]. Proteolytic activity was measured concurrently by the casein digestion technique of Kunitz[6]. The results of this experiment are shown in Fig. 1.

In the absence of urea, the rate at which *p*-nitrophenol was liberated closely paralleled the loss in proteolytic activity, a finding which is in complete accord with that of Kilby and Youatt[3]. In the presence of urea, a similar rate of release of *p*-nitrophenol was observed. The maximum amount of *p*-nitrophenol liberated per given amount of trypsin was very nearly the same in the presence or absence of urea. Of particular interest, however, is the fact that in the presence of urea the proteolytic activity of the

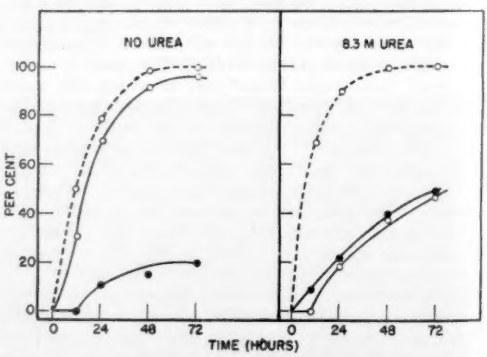

Fig. 1. Loss in proteolytic activity and the release of *p*-nitrophenol in the presence and absence of 8·3 *M* urea. The ordinate for the solid curve is the loss in proteolytic activity as a percentage of its initial value, and the ordinate for the broken curve is *p*-nitrophenol liberated as a percentage of its maximum value. ○, with diethyl *p*-nitrophenylphosphonate; ●, in the absence of diethyl *p*-nitrophenylphosphonate

enzyme was essentially unaffected by diethyl *p*-nitrophenylphosphonate. The loss in activity that did ensue may be attributed to the instability of the enzyme which was apparent even in the absence of diethyl *p*-nitrophenylphosphonate (see curves drawn through the solid circles).

In line with these results, it may be mentioned that inactive diethyl phosphoryl trypsin was prepared by allowing trypsin to react with an excess of diethyl *p*-nitrophenylphosphonate followed by dialysis and lyophilization. The proteolytic activity of this preparation could be partially restored (15–20 per cent) by treatment with 8·3 *M* urea under certain conditions.

These observations are in accord with a hypothesis that the site at which diethyl *p*-nitrophenylphosphonate reacts with trypsin is not identical with the site which is involved in the combination of trypsin with the protein substrate. Normally, the configuration of the enzyme molecule is such that the site of reaction with diethyl *p*-nitrophenylphosphonate is in close proximity to the enzymatic site, so that chemical modification of the former interferes sterically with the accessibility of the second site for substrate combination. The effect of urea, however, may be so to alter the configuration of the trypsin molecule that these two sites are separated and free to exert their characteristic activities. Whether the structural modification effected by urea involves an unfolding of the molecule or fragmentation into smaller units is a problem now under consideration.

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Spectroscopic Observations on Commercial Preparations of Cytochrome *c*

It is generally agreed that reduced cytochrome *c* shows absorption bands in the visible spectrum at 550 mμ (α-band) and at 520 mμ (β-band); in fact, the presence of these two absorption bands is the principal means of detecting reduced cytochrome *c* in a biological object. Keilin and Hartree[1] have observed the absorption bands of cytochrome *c* dissolved in 50 per cent glycerol and in the vitrified or devitrified states at the temperature of liquid air or oxygen, a procedure by which the absorption bands can be intensified and sharpened; under these conditions they report that a fine satellite band appears next to the α-band on its short-wave side, and the β-band appears to be a complex of several peaks. In connexion with studies on the cytochrome absorption bands of Protozoa[2], we have examined the absorption bands of two commercial preparations of cytochrome *c* (beef heart, salt-free, Sigma Chemical Co.; Boehringer und Söhne, Mannheim) using the liquid-air cooling technique of Keilin and Hartree. A 0·07 per cent (w/v) solution of Sigma cytochrome *c* and a 0·2 per cent (w/v) of Boehringer cytochrome *c* in 70 per cent (v/v) glycerol buffered at *p*H 7·0 with 1/50 *M* phosphate were either oxidized with potassium ferricyanide (2·5 m*M*) or reduced with sodium sulphoxylate (in excess) and examined in the liquid state (23° C.) and after cooling to − 196° C. in liquid nitrogen in a flattened 'Pyrex' tube (light path approximately 5 mm.). The higher concentration of the Boehringer cytochrome *c* was necessary in order to reach the same degree of absorption (O.D. 0·4) as the Sigma preparation at 550 mμ. 70 per cent glycerol proved to be more satisfactory than the 50 per cent used by Keilin and Hartree for observation of the absorption lines. The observations were made with a Zeiss Mikro-Specktralokular (Abbe) using a carbon arc lamp (Phywe 8150) as the source of light, and placing the cytochrome preparation above the microscope condenser. With the vitrified material the observations were completed within 30 sec. after removal from the liquid nitrogen. The spectroscope scale was standardized against the mercury line at 546 mμ. Both commercial preparations of cytochrome *c* showed exactly the same extinction bands, and the results in Table 1 therefore apply to both.

Table 1

Bands	Absorption lines in the visible spectrum for commercial cytochrome *c*			
	Reduced		Oxidized	
	Liquid (23° C.)	Vitreous (− 196° C.)	Liquid (23° C.)	Vitreous (− 196° C.)
	509 mμ	500 mμ 508 „ 511 „	very weak, darkening between 520 and 545 mμ and also between 560 and 565 mμ	very weak, darkening between 525 and 538 mμ and also between 560 and 565 mμ
β	522 mμ 528 „	517 mμ 519 „ 523 „ 528 „		
	540 mμ	538 mμ		
α	545–552 mμ	544 mμ 54[illegible] „		

In the reduced state, even at room temperature, very faint bands appeared at 509, 528 and 540 mμ in addition to the usual intense α- and β-bands. Observed in the Beckman *DU* spectrophotometer, these three weak bands appear as shoulders on the absorption curve. Cooling in liquid nitrogen results in striking changes. In addition to a sharpening and intensification of the bands seen at room temperature, a number of new bands appear. There are now very intense and sharp bands at 544 and 549 mμ, fainter but very sharp bands at 508, 517 and 519 mμ, slightly more faint bands at 523, 528 and 538 mμ, and finally two very faint and sharp bands at 500 and 511 mμ. The α-band has been resolved into two bands (544 and 549 mμ) of nearly equal intensity. Maximum intensification of the bands requires about 20 min. immersion in the liquid nitrogen. For unexplained reasons we did not achieve the intensification of the absorption bands by devitrification described by Keilin and Hartree[1]. The same preparation viewed in the glassy state (− 196° C.) with only a tungsten microscope lamp (9 V., 6 amp.) revealed only the 549, 544, 517–19, 528, 523 and 508–11 mμ bands in order of decreasing intensity. A reduced 0·2 per cent (w/v) Sigma cytochrome *c* solution containing

1/15 *M* phosphate, *p*H 7·0, and observed with the same lamp at 23° C. showed absorption bands at 544–552, 519, 528, 509 and 540 mμ.

We are not in a position to say whether these extra bands belong to cytochrome *c* itself, or to partial degradation products of cytochrome *c*[2], or whether they result from the presence of other cytochromes in the preparation. In any event, to our knowledge, these accessory bands have not been previously reported.

The Sigma cytochrome *c* reduced with hydrogen plus palladium–asbestos according to the method of Smith[4] became autoxidized with a first-order rate constant of 3×10^{-3} min.$^{-1}$ (*p*H 7·0, 1/15 phosphate, 22° C., pO_2 equal to 0·2 atm., measured as decrease in optical density at 550 mμ).

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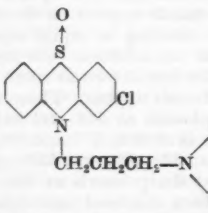
Identification and Pharmacological Properties of a Major Metabolite of Chlorpromazine

Chlorpromazine is widely used in the treatment of mental illness, but little is known about its metabolic fate. This communication describes the discovery in the urine of dog and man of the sulphoxide derivative and some preliminary studies of its pharmacological properties.

The metabolite was extracted from alkaline urine with ether, separated from chlorpromazine by countercurrent distribution, and isolated as the picrate. The empirical formula of the metabolite differed from that of chlorpromazine by one additional oxygen atom. The ultra-violet absorption spectrum of the hydrochloride showed a series of peaks similar to these reported for the sulphoxide of phenothiazine[1]. Identification of the urinary product as the sulphoxide of chlorpromazine:



was established by comparison with the synthetic product. Identity was shown by melting point (207–209° C.) and mixed melting point determination of picrates, and by comparison of ultra-violet and infra-red absorption spectra. Sulphoxide formation is an unusual type of drug bio-transformation, and so far as we know has not been reported; furthermore, the sulphur atom in the metabolite represents a centre of asymmetry[2].

The urinary excretion of chlorpromazine and its metabolite were measured by ultra-violet spectrophotometry (Salzman, N. P., Greenberg, B., and Brodie, B. B., unpublished work). Following the intravenous injection of chlorpromazine (20 mgm./kgm.) into dogs, about 1 per cent was excreted unchanged and about 12 per cent as the sulphoxide. The sulphoxide was also shown to be extensively metabolized *in vivo*; thus, following administration of the metabolite, only about 20 per cent appeared in the urine unchanged. It is probable, therefore, that sulphoxide formation represents a major pathway of chlorpromazine metabolism. Studies with patients receiving chlorpromazine indicated that significant quantities of sulphoxide, but little or no chlorpromazine, were excreted in urine.

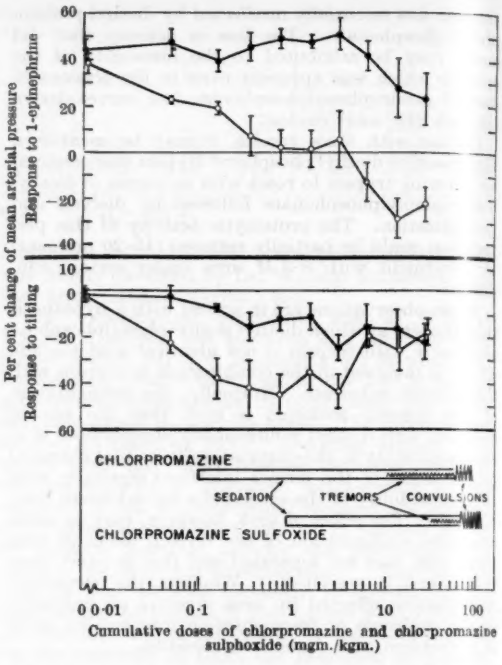


Fig. 1. Effects of chlorpromazine and chlorpromazine sulphoxide on unanæsthetized dogs. Each point represents mean response of four dogs with standard error of the mean depicted by vertical bars. Open circles, chlorpromazine; closed circles, chlorpromazine sulphoxide

Pharmacological actions of chlorpromazine and its sulphoxide were compared in dogs. The compounds were given intravenously in geometrically increasing doses at 15-min. intervals, and vasomotor responses to adrenalin and to tilting recorded. The compounds were qualitatively similar, producing sedation, relaxation of the nictitating membrane, adrenergic blockade, orthostatic hypotension, excitement, tremors, and finally clonic and tonic convulsions. The dose-response relationships are illustrated in Fig. 1. The dose of sulphoxide which produced minimal sedation was about eight times that of chlorpromazine, but the sulphoxide caused relatively little adrenergic blockade and postural hypotension at sedative doses. Because of the difficulty in evaluating sedation quantitatively, the values given in Fig. 1 for the minimal sedative doses are only approximate, with no attempt to measure the degree of sedation.

Since chlorpromazine potentiates barbiturates by a central action[3], the effectiveness of the two compounds in potentiating hexobarbitone anæsthesia

was compared. Dogs were anæsthetized with hexobarbitone and on awakening were given chlorpromazine or the sulphoxide intravenously. Resumption of anæsthesia, indicating potentiation, was observed with both compounds, the sulphoxide being about one-eighth as active as chlorpromazine. In contrast to its activity in dogs, the sulphoxide produced only minimal sedation and potentiation of hexobarbitone in mice, rats and rabbits.

Since chlorpromazine sulphoxide induces sedation in dogs with relatively little of the orthostatic hypotension observed with chlorpromazine, it is planned to test the drug in man in the treatment of mental illness.

We wish to thank Dr. Glenn Ullyot, of the Smith, Kline and French Laboratories, for supplying chlorpromazine sulphoxide.

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Function of Heparin

BOTH heparin[1] and histamine[2] are now known to be concentrated in the tissue mast cells, and it might thus be expected that the release of histamine caused by damage to the mast cells would be accompanied by the release of heparin and a consequent increase in the clotting time of blood. So far this dual effect has been observed in only one species, the dog, in which an intravenous injection of peptone or of a chemical histamine liberator such as compound 48/80 can release sufficient heparin to render the blood incoagulable. In the rat, however, although compound 48/80 releases histamine from the numerous mast cells in the subcutaneous connective tissue, the clotting time of the rat's blood remains unchanged. We have therefore attempted to discover what happens to the heparin in the rat following a maximal release of histamine by compound 48/80.

Two groups of eight female Wistar rats, of 200–250 gm., were used. The first received intraperitoneally over a period of five days progressively increasing doses of compound 48/80 in saline, by which time 1 mgm. per 100 gm. body-weight could be given without eliciting signs of shock. The second group was given equivalent volumes of saline intraperitoneally as a control. Whole blood-clotting times were measured repeatedly by the capillary tube method, and samples of urine, collected on filter paper, were tested for metachromatism with a weak solution of toluidine blue. At the end of five days, the two groups were killed and skinned, and as much subcutaneous connective tissue as possible was scraped off. Representative tissue spreads were examined histologically for mast cells, the remaining subcutaneous tissue (about 60 gm.) in each group being then pooled and assayed for histamine and heparin as previously described[3], except that on this occasion we used the thiocyanate method[4] for the initial extraction before finally purifying the heparin by the method of Charles and Scott[5].

Compound 48/80 in the dosage used produced widespread degranulation and disruption of the mast cells in the subcutis of rats, and almost complete loss of its tissue histamine—a drop from 26 to 1·5 μgm./gm. tissue (94 per cent loss). On the other hand, the total heparin content fell only from 10·0 to 4·7 I.U./gm. (53 per cent loss), and even this loss was unaccompanied by any sign of the release of heparin into the circulating blood; the clotting time remained normal and no metachromatic material appeared in the urine. That the heparin extracted from the control series did in fact possess anticoagulant activity was confirmed by its action on normal rat blood *in vivo* and *in vitro*.

Thus the almost complete release of histamine from the subcutis of the rat by compound 48/80 is accompanied by a loss of only half the associated heparin. Some of the metachromatic material from the disrupted mast cells may be disposed of locally by macrophages[6,7], some may adhere to adjacent connective tissue fibrils[8] or cells[9], while some may be bound by the basic histamine-liberator itself[10]. Although these same basic compounds can release active heparin into the blood stream of the dog[11], they fail to do so in the rat; the rabbit and the guinea pig appear to be similar to the rat in this respect[12]. This suggests that the function of heparin may be concerned rather with events in the tissues than with the coagulability of the circulating blood.

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Inactivation of Phenyl Mercuric Acetate in Groundwood Pulp by a Mercury-resistant Strain of *Penicillium roqueforti* Thom

AN investigation was started in December 1954 into the storage qualities of groundwood pulp impregnated with 25–35 p.p.m. of phenyl mercuric acetate, compared with unimpregnated pulp made at the same time. One object of this work was to follow the course of infection of the pulps by blueing and wood-rotting fungi (Basidiomycetes), the latter frequently being responsible for the condition known

as 'red-rot', and also to try to discover why phenyl mercuric acetate, although toxic to many Basidiomycetes at low concentrations, frequently fails to protect groundwood pulp from attack by 'red-rot' after a few months storage. Some significant conclusions have now been reached.

Phenyl mercuric acetate is highly toxic to many fungi at 2–10 p.p.m. mercury, but it has been known[1,2] for some years that a strain of *Penicillium roqueforti* Thom can tolerate very much higher concentrations. This mould commonly stains mercury-treated pulp quite badly, but it is not cellulolytic. It is mainly infection by Basidiomycetes that causes pulp to deteriorate.

We have shown experimentally that *P. roqueforti* isolated from pulp impregnated with phenyl mercuric acetate can absorb mercury into its mycelium. The mould was grown on liquid media containing 20 p.p.m. of phenyl mercuric acetate. After a month, the mycelium was filtered off, washed and analysed for mercury. About 75 per cent of the weight of mercury found on analysis was present in the fungal pellicle. This suggested that the mould might be able to prevent this fungicide from behaving as a thiol reactor towards more harmful fungi known to be very susceptible to phenyl mercuric acetate *in vitro*.

Monthly examination of bales of both untreated and mercury-treated pulp (manufactured in December 1954) showed that *P. roqueforti* stains first appeared in the treated pulp about eight weeks after manufacture. We have very seldom isolated this mould from untreated pulp. The stains gradually spread farther into the bales month by month; but, unlike the unprotected bales, no evidence of 'red-rot' attack was then apparent. Five months after manufacture, the untreated bales were badly rotted, and the treated bales were extensively stained by *P. roqueforti*. One impregnated bale examined contained a few consecutive sheets having, in addition to the *Penicillium* stains, a small brown stain at one edge, typical of a Basidiomycete. Attempts to isolate the causal fungus failed at this stage.

A suitable bio-assay technique had meanwhile been found for determining the amount of biologically active mercury present in groundwood pulp. Chemical analysis showed that the normal concentration of 25–35 p.p.m. of mercury was present in the pulp sheets; but bio-assay tests showed that the concentration of biologically active mercury fell from 12–13 p.p.m. mercury in the unstained central areas to 3·4 p.p.m. one inch beyond the border of the *P. roqueforti* stains, and was zero in the stains themselves. The difference in concentration of bio-active mercury compared with total added mercury in the uninfected areas of the sheet is presumably due mainly to partial inactivation by some natural constituents of the pulp. In no case has any biologically active mercury been found in *P. roqueforti*-stained regions of impregnated groundwood pulp containing 25–35 p.p.m. mercury.

Six months from the date of manufacture, the outer regions of the treated bales were quite badly infected by 'red-rot', and *Stereum sanguinolentum* was isolated on a specially developed selective medium which is designed to inhibit fast-growing contaminating moulds, such as *Trichoderma viride*, without affecting the growth of Basidiomycetes.

After seven months, 'red-rot' due to *Stereum sanguinolentum* was well established, and no bio-active mercury was detectable anywhere in the infected sheets. The normal content of mercury was found by chemical analysis.

The evidence obtained shows that: (*a*) the strain of *P. roqueforti* Thom normally present in mercury-treated pulp is able to absorb a relatively large amount of mercury from nutrient media containing phenyl mercuric acetate; (*b*) progressive infection of groundwood pulp by this mould reduces concurrently the concentration of biologically active mercury to nil in the stained areas, without affecting the concentration of mercury determinable by chemical analysis; and (*c*) the loss of biologically active mercury in the pulp studied was followed by secondary infection by *Stereum sanguinolentum*, which caused a typical 'red-rot'. It is therefore suggested that *P. roqueforti* Thom is able to render phenyl mercuric acetate inactive as a fungicide, and hence reduce its value as a pulp preservative against secondary infection by wood-rotting fungi.

It follows that more efficient protection against rot should be conferred by using either a non-mercurial toxicant, or a mixed toxicant containing a non-mercurial, to which *P. roqueforti* is susceptible at concentrations lethal to Basidiomycetes. Successful treatment on these lines has already been reported[3].

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Use of the Glees Silver Technique in the Hypothalamus

One of the most important advances in technical procedures for determining the course and distribution of fibre tracts in the central nervous system is the method based on the recognition of terminal degeneration by silver impregnation. As the authors of these methods have emphasized, however, they need to be used with care and discrimination in order to avoid possible fallacies of interpretation. We have recently observed that in certain (but not all) of the cell groups of the hypothalamus and preoptic region in a number of normal brains (human and macaque monkey) stained by the Glees technique, the appearance of apparently typical terminal degeneration is present. This is particularly the case with the dorsomedial and ventromedial hypothalamic nuclei. The reason why these nuclei should show this appearance of 'degeneration' is not clear; but it may be related to the peculiar metabolic activities which are known to modify the appearance of axons in some of the hypothalamic nuclei. This observation is of importance since it is probable that some investigators have, in the past, mistaken this appearance seen in sections of normal brains for true terminal degeneration, and on this basis have described fibre connexions with widely different parts of the brain.

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Blocking of Lead Tetraacetate–Schiff Reactions in Tissue Sections by Boric Acid

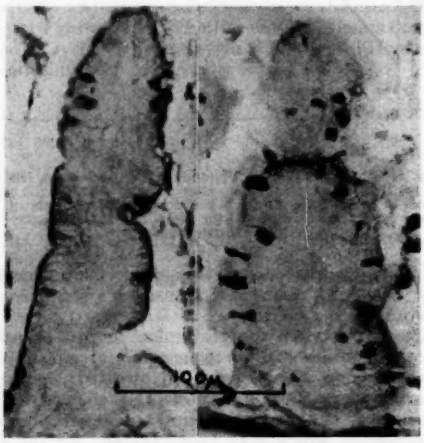
CURRENT histochemical techniques for carbohydrates depend on the fact that many of these substances possess groupings capable of being oxidized to yield aldehyde residues, which can then be made visible with Schiff's reagent. Glegg, Clermont and Leblond[1] showed that when lead tetraacetate (in glacial acetic acid) replaced periodic acid as the oxidant, the histological distribution of the reaction with Schiff's reagent was similar although the intensity at some sites differed. If this difference in the intensity of the Schiff reactions were due to preferential oxidation of *cis* α-glycol groupings by lead tetraacetate[2], then boric acid, which readily complexes with *cis*-hydroxyl groups (for example, in carbohydrates)[3], might be expected to block the oxidation of such groups and thus modify the subsequent Schiff reaction.

Sections of mouse tissues were treated with a 1 per cent w/v solution of lead tetraacetate (L. Light and Co.) in glacial acetic acid containing 0·1–0·001 *M* boric acid. Controls were processed without boric acid. The presence of boric acid reduced or completely prevented the subsequent reaction with Schiff's reagent only in certain structures, for example, mucus-secreting cells (Figs. 1 and 2). This effect was better demonstrated with ethanolic Schiff's reagent[4]. If sections were successively treated with boric acid in glacial acetic acid and lead tetraacetate, the Schiff reaction was not blocked, nor was the effect of a solution containing both reagents enhanced.

'Model' experiments with galactogen[5] and glycogen (Kahlbaum) incorporated in gelatin films have shown that, histochemically as well as chemically[2], lead tetraacetate oxidizes adjacent *cis*-hydroxyl groups more rapidly than adjacent *trans*-hydroxyl groups; and that boric acid modifies the subsequent Schiff reaction, probably by forming oxidation-resistant complexes with adjacent *cis*-hydroxyl groups of carbohydrates. Since these groups are present in several animal glycoproteins[1], these results may also apply to the tissue sections.

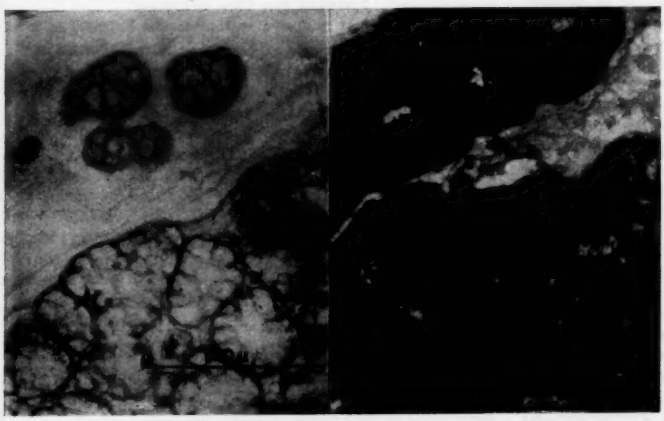
Sections of a gingival biopsy from a case of phenytoin sodium gingival hyperplasia (Fig. 3), in which there is increased production of collagen[7], were placed in a 0·8 per cent w/v solution of pectinase (L. Light and Co.), *p*H 4·2, for 21½ hr. at room temperature; after washing, they were treated first with lead tetraacetate solution and then with aqueous Schiff's reagent. The action of the pectinase was similar to that reported for dermis[8]; but it was found that with boric acid present in the lead tetraacetate solution, little or no staining took place. This suggests that 'pectinase' releases the α *cis*-hydroxyl structure from collagenous and reticular fibres, presumably from carbohydrate components[8,9], and also illustrates a possible application of the boric acid blocking technique in studies on enzymes of unknown specificity acting on complex substrates.

Fig. 3. Gingiva from a patient with phenytoin sodium gingival hyperplasia, stained by Gomori's method, showing collagenous and reticular fibres in the lamina propria between two epithelial ridges



(a) (b)

Fig. 1. Goblet cells of small intestine, in ethanolic Schiff's reagent after 4 hr. at 23° C. 1 per cent lead tetraacetate; (a) containing 0·01 *M* boric acid, (b) without boric acid



(a) (b)

Fig. 2. Mucous glands of larynx, in ethanolic Schiff's reagent, as in Fig. 1

Further work is in progress, and will be reported elsewhere. I wish to thank Dr. D. J. Bell for a specimen of galactogen, and Dr. L. N. Owen for advice and encouragement.

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Role of Glutamine in Urea Synthesis

In 1939, it was suggested by one of us[1] that the amide-nitrogen of glutamine was a source of urea-nitrogen and that urea formation was paralleled by a continuous re-synthesis of glutamine. Evidence has now been obtained for a reaction between bicarbonate (as the source of urea-carbon) and the two nitrogenous groups of glutamine. This appears to represent the first of the sequence of reactions leading to urea synthesis. The evidence for this step is based on the observation that when liver slices are incubated with glutamine in absence of added bicarbonate, not only was urea synthesis practically suppressed but also neither the glutamine-amide-nitrogen nor the amino-nitrogen of glutamine was utilized to any extent. On the other hand, in the presence of bicarbonate a considerable synthesis of urea occurred with the simultaneous utilization of amide-nitrogen and of amino-nitrogen (Table 1). The small quantities of ammonia derived from glutamine and formed during the incubation were unaffected by bicarbonate and therefore appear to be unrelated to urea synthesis. That glutamine rather than ammonia or ammonium glutamate acted as a direct source of urea-nitrogen was demonstrated in several ways: first, by the fact that the rate of urea synthesis from glutamine was directly proportional to the substrate concentration, whereas this was not so when ammonia served as a substrate (Fig. 1). A slight inhibitory effect of ammonia was observed at the highest concentrations tested. Secondly, inhibition of glutaminase by sulphophthaleins had no effect on the synthesis, whereas activation of glutaminase with pyruvate almost completely inhibited urea formation. Finally, evidence was obtained by paper chromatography for a considerable formation of glutamine from ammonium salts in liver slices. These observations provide evidence for the role of glutamine, as distinct from ammonium glutamate, in urea synthesis

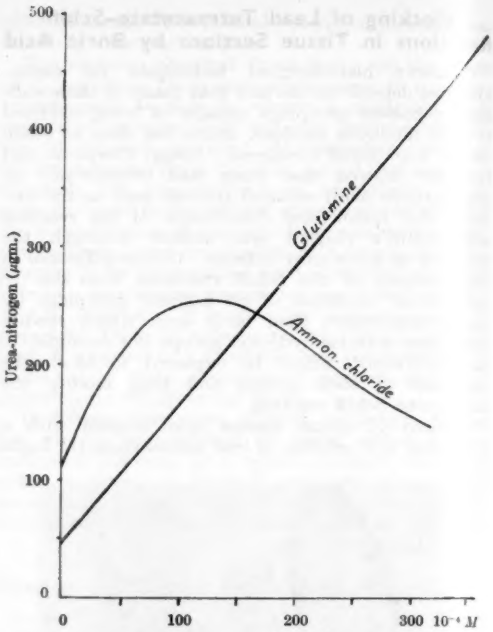


Fig. 1. Urea synthesis from glutamine and ammonium chloride in rat liver slices; incubation time 90 min. at 37°; 200 mgm. slices in bicarbonate Ringer. The positions of the lines on the graph were calculated from the results of approximately 200 experiments

and suggest that urea formation from ammonia may depend upon a transitory formation of glutamine.

Attempts to replace glutamine in urea synthesis by other amides such as asparagine, glycineamide or oxamide were unsuccessful. However, preliminary experiments with *iso*glutamine (II) showed a great superiority of this compound over glutamine, a phenomenon which may be significant for the interpretation of the synthesizing mechanism discussed below.

Table 1. Effect of Bicarbonate on the Utilization of Glutamine Nitrogen for Urea Synthesis

200 mgm. liver slices incubated with glutamine (0·02 *M*) in 4 ml. Ringer solution buffered at *p*H 7·4

	Utilization of glutamine		Formation of	
	Amide-nitrogen (μgm.)	Amino-nitrogen (μgm.)	Ammonia-nitrogen (μgm.)	Urea-nitrogen (μgm.)
With bicarbonate	170	145	37	287
Without bicarbonate	66	25	36	34

Table 2. Contribution of Glutamine-Nitrogen to Urea-Nitrogen

Figures represent averages of eight experiments: conditions as in Table 1

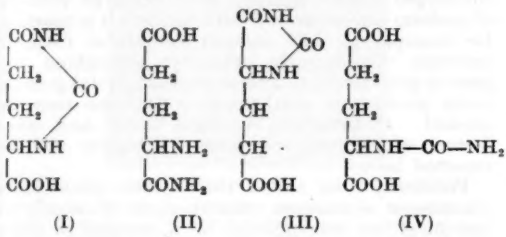
Contribution from:			Formation of urea-nitrogen
Amide-nitrogen	Amino-nitrogen	Total glutamine-nitrogen*	
166 μgm.	156 μgm.	281 μgm.	264 μgm.

* Corrected for small quantities of ammonia-nitrogen liberated during incubation.

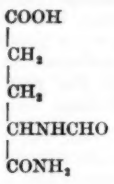
In a further series of experiments, the urea formed from glutamine and bicarbonate in liver slices was estimated side by side with the disappearance of amide-nitrogen and amino-nitrogen. These balance experiments (Table 2) showed that the contribution of amide-nitrogen to urea-nitrogen approximately equalled that of the amino-nitrogen. They further revealed that the sum of the contributions of amide-nitrogen and amino-nitrogen, corrected for the small quantities of free ammonia formed during the incubation, was of the same order as the total urea-nitrogen synthesized. It is therefore concluded that the following equation represents the overall synthesizing mechanism :

1 glutamine-amide-nitrogen + 1 glutamine-amino-nitrogen = 2 urea-nitrogens

Experiments with sodium bicarbonate(^{14}C) and with other monocarbon compounds confirmed the original view of Krebs and Henseleit[2] that bicarbonate is the principal, if not the only source of carbon for urea. Thus, as described above, it is bicarbonate or a derivative which reacts initially with the nitrogenous groups of glutamine. Whether this reaction is directly linked with the ornithine cycle of Krebs and Henseleit[2] was not investigated in this work.

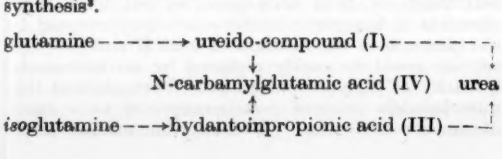


(I) (II) (III) (IV)



(V)

As a result of the initial reaction, the formation of a ureido-compound of type (I) could be envisaged. However, in view of the strong effect of *iso*glutamine on urea synthesis, it is also possible that *iso*glutamine rather than glutamine may act as the principal source of nitrogen. In this case the subsequent formation of hydantoinpropionic acid (III) could be postulated. A hydrolytic split of the amide-nitrogen linkage or an oxidative split of the amino-nitrogen linkage of the compounds (I) and (III) would lead to the formation of carbamyl derivatives. If the hydrolytic split occurred first, N-carbamylglutamic acid (IV) would arise from either compound, an intermediary which has been reported to act as a catalyst in urea synthesis[3].



The transitory formation of hydantoinpropionic acid (III) from *iso*glutamine (II) in urea synthesis is particularly worthy of consideration, since it has been claimed that these two compounds as well as the closely related formyl*iso*glutamine (V) occur as intermediates during the degradation of histidine[4], which is one of the strongest urea-synthesizing amino-acids[5].

A detailed account of this work will appear elsewhere.

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Hæmagglutinins of *Glycine soja*

The hæmagglutinins of *Glycine soja* (synonyms : *Glycine max*, *Soja hispida*, *Dolichos soja*, *Soja angustifolia*), stated to be inactive against human erythrocytes but active against certain animal cells, particularly those of the rabbit[1], have been found to agglutinate human red blood corpuscles non-specifically in the cold[2].

I observed[3] that when extracts of the seeds of *Glycine soja* (var. Bansei) were absorbed in the cold with human erythrocytes of group *O*, until they were no longer agglutinated, the extract could still agglutinate *A* and *B* cells, not only in the cold, but also at 37° C. Subsequent absorption with corpuscles of group *A* left residual activity for those of group *B*. The anti-*O* component of these extracts appeared to suppress the activity of the anti-*A* and anti-*B* components.

Further studies of *Glycine soja* extracts have now been conducted which have shown that the extracts contain incomplete agglutinins for human red blood corpuscles, since albumin suspensions of human erythrocytes and papainized human red cells are agglutinated non-specifically at laboratory temperatures and at 37° C.

Glycine soja therefore appears to contain : (i) agglutinins acting powerfully, even at 37° C., on rabbit erythrocytes suspended in saline ; (ii) non-specific cold agglutinins for human erythrocytes suspended in saline ; (iii) incomplete agglutinins for human erythrocytes, acting both in the cold as well as at higher temperatures.

Absorption and elution experiments, to be described elsewhere, have shown that the same agglutinins are responsible for the diverse serological reactions indicated above.

It appears that the thermal amplitude of *Glycine soja* agglutination is not entirely a property of the agglutinins, because the same agglutinins have widely differing thermal amplitudes for human and rabbit erythrocytes. It appears that cell receptors play a part in determining the thermal amplitude of *Glycine soja* agglutination.

It is conceivable that a mixture of complete cold agglutinins and incomplete warm agglutinins can give

rise to the suppression phenomenon[3]. However, as the cold agglutinins and the incomplete agglutinins appear to be identical, the mystery of the separability of component agglutinins for *O*, *A* and *B* erythrocytes and the increased thermal amplitude after absorption with red corpuscles of group *O* remains to be solved.

G. W. G. Bird

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Poona.
July 19.

[1] Krupe, M., *Biol. Zentralbl.*, **72**, 424 (1953).
[2] Bird, G. W. G., *Curr. Sci.*, **22**, 273 (1953).
[3] Bird, G. W. G., *Brit. J. Haemat.* (in the press).

Production of Diphtheria Toxin in Submerged Culture

We have shown[1] that diphtheria toxin with a value of 150–200 flocculating units per ml. can be obtained by growing the Park–Williams No. 8 strain of *C. diphtheriae* as a submerged culture, using a tryptic digest medium based on that described elsewhere[2]. The volumes employed were 10–14 litres of medium, and the vessels were of glass, with stirrers made of either 'Birmabright' (a magnesium–aluminium alloy) or aluminium.

In recent developments of this technique, we have used 80-litre tanks, made from commercial aluminium, which offer many advantages over glass vessels for routine toxin production. They permit of a much better control of temperature during the growth of *C. diphtheriae* and are more suitable for sterilization of the culture medium. Vortex stirring[3] has been used, and sterile air at a rate of 0·05–0·15 litre per min. per litre of culture medium has been found satisfactory.

The time required for maximal toxin production has been found to be very dependent on the size of the initial inoculum employed. For routine toxin production a growth period of the order of 48 hr. is very convenient, and for this an initial inoculum of 200 ml. of a 48-hr. shaken culture of *C. diphtheriae* for a volume of 50–60 litres of medium has been found satisfactory. If a much larger inoculum is used, for example, 10 litres of 24-hr. culture produced in a small seed-tank, peak toxin production is obtained in about 28 hr.

As an alternative method, we have withdrawn approximately half the culture when the peak toxin value has been reached and replaced it with an equal volume of fresh sterile medium. After this replacement, the toxin production is a maximum in 24 hr., and this procedure may be repeated many times, thus giving in effect a semi-continuous daily toxin production of 30 litres per tank. Unfortunately, the initial purity of the toxin, which is of the order of 1,500 Lf. units per mgm. protein nitrogen, is not maintained, and for this reason we prefer to harvest single batches of toxin rather than to run a semi-continuous process. An example of a result obtained in this way is shown in Table 1.

With the equipment and methods now in use, we have been able to produce large volumes of culture filtrates from *C. diphtheriae* having an Lf. value of the order of 180–250 units per ml. The advantages of submerged culture methods over the older surface-culture technique are very obvious. Toxin production in shallow layers of culture medium necessitates the manipulation and inoculation of hundreds of bottles

Table 1. Submerged Culture No. 187
Aluminium tank with vortex stirrer, capacity 80 litres. Culture medium: 50 litres of tryptic digest medium. Inoculum: 10 litres of a 24-hr. growth of *C. diphtheriae* prepared in a small submerged culture tank. Air flow: 6 litres per min. across the surface. Temperature: 35° C.

Growth time (hr.)	*p*H	Lf. (U./ml.)	Protein nitrogen (mgm./ml.)	Purity (Lf./mgm. protein nitrogen)
0*	7·85	15		
2	7·65	17		
4	7·72	22		
6	7·80	34		
8	7·82	51		
10	7·87	69		
12	8·05	85		
23	8·30	206	0·138	1,490
25	—	212		
28†	8·40	235	0·154	1,510
29	7·98	117		
30	7·88	114		
32	8·06	133		
34	8·10	155		
36	8·18	168	0·126	1,320
47	8·32	252		
49	8·49	259	0·195	1,330

* Initial values after inoculation.
† At 28 hr., 35 litres of culture were removed and replaced by 30 litres of sterile culture medium.

—a laborious process where comparatively large amounts of culture filtrate are required. By the submerged culture method, however, large volumes of medium can be handled with ease and it is possible, for example, to take uniform samples at frequent intervals (for example, 2-hourly) throughout the growth period so that determinations of total growth, toxin production, and metabolic changes may be studied. Observations on these points and other factors which influence toxin production will be reported later.

Previously[1], we stated that vessels made from commercial aluminium showed signs of attack on continued use, accompanied by a decrease in toxin production. The vessels now in use (of modified design) have not shown this attack, and there has been no decrease in toxin production on continued usage. Possibly a difference in composition of the aluminium used for the first experimental tank accounted for this finding.

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July 29.

[1] Linggood, F. V., Matthews, A. C., Pinfield, S., Pope, C. G., and Sharland, T. R., *Nature*, **174**, 557 (1954).
[2] Linggood, F. V., and Fenton, E. L., *Brit. J. Exp. Path.*, **28**, 354 (1947).
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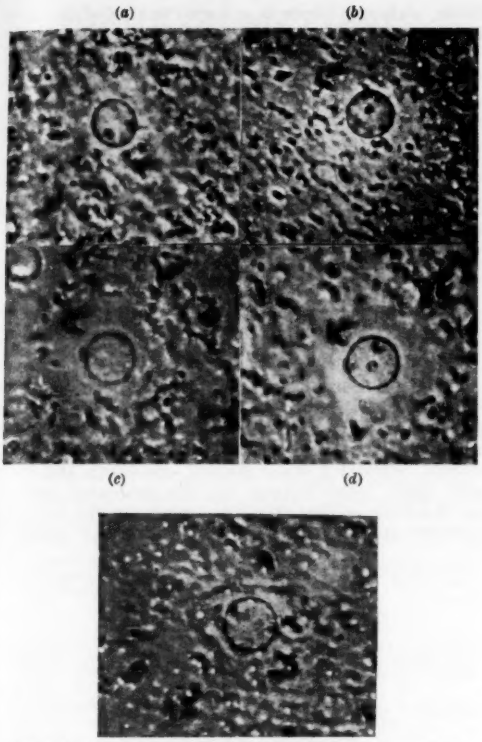
Preservation of Rat Liver Nuclei by Potassium Glycerophosphate

Appelmans and de Duve[1] found that the 'osmotic activation' or lysis undergone by rat liver mitochondria in hypotonic media could be prevented by the presence in the medium of 0·25 *M* sucrose; the sucrose could be partly replaced by an iso-osmolar quantity of β-glycerophosphate. They showed that mitochondria released certain enzymes as a result of osmotic activation. If deoxyribonuclease, which



Phase-contrast photographs of nuclei in rat liver homogenates

Fig. 1. Nuclei from homogenate in solution *A*: (*a*) immediately after preparation; (*b*) after standing at room temperature for 2 hr.; (*c*) surrounded by 'halo' formed by suspending in *M* sodium chloride, immediately after preparation; (*d*) halo still formable 2 hr. later

Fig. 2. Halo no longer formable around nucleus left in solution *B* for 2 hr.

Solution *A*: 0·3 *M* sucrose, 0·06 *M* potassium glycerophosphate, 0·001 *M* magnesium chloride, 40 per cent glycerol. Solution *B*: Control solution with potassium glycerophosphate replaced by 0·005 *M* potassium phosphate buffer. Both solutions at *p*H 7·0

Schneider and Hogeboom[2] have shown to be largely associated in liver with mitochondria, is also released by osmotic activation, this might explain the effectiveness of sucrose in media for the isolation and preservation of nuclei. Anderson[3] has shown that sucrose prevents 'bleb' or bubble formation on the nuclear surface, and that bleb formation occurs on nuclei treated with deoxyribonuclease.

We have tested the effectiveness of potassium β-glycerophosphate as a complete or partial substitute for 0·3 *M* sucrose in preserving nuclei in the presence of mitochondria. The criteria used were: (*a*) preservation of the original degree of contrast of the nuclei under the phase-contrast microscope, and (*b*) formation of 'haloes' (Fig. 1,*c*) around the nuclei when suspended in *M* sodium chloride, indicating that deoxyribonucleic acid was still present in a form that is extractable and sufficiently viscous to push the mitochondria away from the nucleus. The other components of the medium were 40 per cent glycerol, 0·001 *M* magnesium chloride, and 0·005 *M* potassium phosphate buffer *p*H 7·0, where there was no glycerophosphate present for *p*H buffering. Under these conditions, 0·16 *M* potassium glycerophosphate was more effective than 0·3 *M* sucrose for preserving nuclei; but it caused them to clump, probably through partial dissociation of nucleohistone. 0·12 *M* and 0·09 *M* were also more effective than sucrose, the higher concentration being better than the lower; their effectiveness was independent of whether sucrose was also present. 0·06 *M* glycerophosphate was effective only if 0·2 *M* sucrose or more was also present, so at this level the effects seem to be additive.

The best combination (solution *A*) appeared to be 0·3 *M* sucrose + 0·06 *M* potassium glycerophosphate, plus the other components mentioned above (Figs. 1,*a* and *b*). When this mixture was used, viscous deoxyribonuclease was still extractable after leaving nuclei in the presence of mitochondria at room temperature for periods up to 24 hr. (Figs. 1,*c* and *d*). Fig. 2 shows that this was not the case when glycerophosphate was replaced by 0·005 *M* potassium phosphate buffer (solution *B*). It is not clear why potassium glycerophosphate should be more effective than sucrose; but the results fit in with de Duve's findings, and suggest that the protective action of both substances on nuclei may be due to their prevention of the liberation of deoxyribonuclease from mitochondria. With all mixtures used, the fewer mitochondria there were present, the longer the nuclei were preserved.

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July 29.

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Inability of Varied-Carpet Beetle Larvæ (*Anthrenus verbasci* L.) to digest Chitin

A few animals are known to possess in their digestive juices a chitinase enabling them to digest chitin. The occurrence of a chitinase in the gut of the snail (*Helix pomatia* L.) was demonstrated long ago[1]. A similar enzyme is present in the intestinal tract of different earthworms[2], eelworms[3], snails and slugs[4], and in the terrestrial isopod *Porcellio scaber* Latr.[5]. Among the snails, and probably also other terrestrial pulmonate gastropods, the intestinal chitinase is not produced by the glands of the animal, but appears to be of microbial origin[4].

It is often thought by entomologists that pests of collection specimens digest chitin and live on a diet containing a high percentage of chitin. However, it has never been demonstrated that this chitin is actually utilized. The following investigations were carried out using varied-carpet beetle larvæ (*Anthrenus verbasci* L.) (Coleoptera, Dermestidae), in order to check their view.

(1) *Absence of chitinase in glycerol extracts of digestive tracts.* Larvæ of *A. verbasci* were reared on dried insects. Fully grown larvæ (about 5 mm. long) were cleaned and carefully dissected under a binocular microscope. Sixty-four isolated digestive tracts were ground in a small mortar with 5 ml. of 5 per cent glycerol and clean sand, at 0° C. After centrifugation, the chitinolytic activity of the clear supernatant fluid was tested, using both nephelometric and chemical methods previously described[4].

After 22 and 72 hr. of incubation, at *p*H 6·5 and 36° C., under aseptic conditions, no chitinolytic activity could be detected.

(2) *Absence of chitinolytic bacteria in the digestive tract.* Four larvæ, grown on dried insects, were cleaned and aseptically dissected in a sterile chamber. The digestive tracts were ground in a sterile mortar and suspended in 2 ml. sterile distilled water. 1 mgm. of excreta of larvæ was similarly suspended in 2 ml. distilled water.

The suspensions were then added to a sterile agar–agar medium containing finely powdered chitin, and plated in Petri dishes[6]. After ten days, no chitinolytic bacteria could be detected: no typical clarification of the medium, such as that usually observed with all chitinolytic bacteria of different sources[4,6], was noticed. Digestive tracts and also excreta are particularly poor in micro-organisms, and seem to be entirely devoid of chitinolytic bacteria.

(3) *Chitin balance in the diet of larvæ reared in controlled conditions.* When reared on a diet consisting of dried insects (adults of *Musca* sp., *Palomena prasina* and *Doryphora decemlineata*), larvæ of *A. verbasci* are able to utilize a maximum of 30 per cent (in dry weight) of the available diet. Two sets of experiments were carried out with larvæ reared for three months on a diet of a known content of chitin, at 28° C. and 50 per cent relative humidity. One control experiment consisted of exposing the same food in the same incubator without larvæ.

In one experiment, chitin was estimated by purification of the material, using the method of Black and Schwartz[7], the residue being weighed as pure chitin. The loss of chitin in the food seemed rather important (28 per cent with dried *Musca* and *Palomena* as diet, 8·5 per cent with *Doryphora*). But this method was found afterwards to be quite unsatisfactory in this particular case owing to the fact that purification is not completed (some proteins remain unhydrolysed) and the excreta, being of a very finely powdered material, are not easily retained during manipulations.

In a second experiment, chitin was estimated by purification of the material with 6 per cent potassium hydroxide at 100° C. for 2 hr.; *N* hydrochloric acid at 20° C. for 2 hr.; again 6 per cent potassium hydroxide at 100° C. for 2 hr.; 1 : 1,000 potassium permanganate at 60° C. for 20 min.; sodium metabisulphite; hot water, alcohol, ether. These different chemical treatments and the washings were performed in centrifuge tubes, the residue being centrifuged after each treatment for a long time, to prevent any loss of small particles. Estimation of chitin in the final residue was by nitrogen determination (Kjeldahl method).

In these conditions, the loss of powdered material was considerably reduced. The difference in chitin–nitrogen between controls and a diet consisting of dried *Palomena prasina* on which fifty larvæ were reared for three months reached 4 per cent only, this value being within the normal limits of error of the method. Thus chitin is not digested and can be nearly completely recovered in a controlled diet, although the cuticles of the dried insects are partially destroyed and reduced to powder by the larvæ.

Hence we conclude that, using an adequate method for the estimation of chitin balance in dried insects eaten by *Anthrenus verbasci* larvæ, no significant loss of chitin could be observed. The digestive tracts of these larvæ are devoid of chitinase and of chitinolytic micro-organisms. Such larvæ are unable to digest chitin, although there is a high content of chitin in their usual diet.

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Université de Liège.
July 22.

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[2] Tracey, M. V., *Nature*, **167**, 776 (1951).
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[5] Jeuniaux, Ch., *Arch. internat. Physiol. Biochem.* (in the press).
[6] Jeuniaux, Ch., *Physiol. Comparata Oecol.* (in the press).
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Supra-Sternal Ossicles in Primates other than Man

Dr. G. T. Ashley's communication[1] prompts me to record a further example of supra-sternal ossicles in primates, this time in *Perodicticus potto*. The specimen, which was the prepared skeleton of a young animal, showed a supra-sternal ossicle on the right side only, contributing to the articular surface for the clavicle (Fig. 1). The ossicle on the left side was presumably lost during preparation. From a comparison with the adult sternum, it would appear that in *Perodicticus* the supra-sternal ossicles are responsible for the prominent antero-lateral angles of the manubrium sterni and thus for the deep supra-sternal notch. It is possible that they are a regular feature in the development of the sternum in this animal. It must not be forgotten, however, that the supra-sternal notch in man is considerably shallower in the newborn than in the adult, though supra-sternal ossicles do not seem to be a constant feature here.

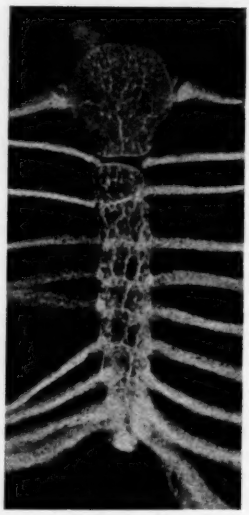

Fig. 1. Radiograph of the sternum of an immature *Perodicticus potto* showing the presence of a supra-sternal ossicle on the right side

D. V. Davies
Anatomy Department,
St. Thomas's Hospital Medical School,
London, S.E.1. Sept. 27.

[1] *Nature*, **176**, 608 (1955).

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Monday, December 12

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE, PHILOSOPHY OF SCIENCE GROUP (in the Joint Staff Common Room, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Dr. A. W. Phillips: "Control Systems in Economics".

SOCIETY OF ENGINEERS (at 17 Victoria Street, London, S.W.1), at 5.30 p.m.—Annual General Meeting.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (in the Reynolds Hall, College of Technology, Manchester), at 5.45 p.m.—Dr. V. E. Yarsley: "The Role of Plastics in Shaping the Pattern for the Future" (Ramsden Memorial Lecture).

PHARMACEUTICAL SOCIETY OF GREAT BRITAIN (at 17 Bloomsbury Square, London, W.C.1), at 7.30 p.m.—Mr. H. A. R. Binney: "The Work of the British Standards Institution".

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 8.30 p.m.—Major-General J. C. T. Willis: "Ordnance Survey and the Public".

Tuesday, December 13

ZOOLOGICAL SOCIETY OF LONDON (in the Mappin Refreshment Pavilion, Mappin Terrace, Zoological Gardens, Regent's Park, London, N.W.1), at 5 p.m.—Scientific Papers.

INSTITUTION OF CIVIL ENGINEERS (at Great George Street, Westminster, London, S.W.1), at 5.30 p.m.—Sir Harold Roxbee Cox: "The Development of the Gas Turbine" (Parsons Memorial Lecture).

ILLUMINATING ENGINEERING SOCIETY (joint meeting with the Royal Institute of British Architects, at the Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 6 p.m.—Mr. Derek Phillips: "Lighting in Buildings—Training and Practice".

INSTITUTION OF ELECTRICAL ENGINEERS, LONDON GRADUATES AND STUDENTS SECTION (at Savoy Place, London, W.C.2), at 6.30 p.m.—Mr. L. A. Harris: "Colour Television".

Wednesday, December 14

PHYSICAL SOCIETY, COLOUR GROUP (at the Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 3.30 p.m.—Mr. W. R. Stevens and Mr. H. M. Ferguson: "Apparent Brightness of Coloured Light Sources".

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers and Exhibits.

BRITISH NUCLEAR ENERGY CONFERENCE (in the Great Hall, Institution of Civil Engineers, Great George Street, London, S.W.1), at 5.30 p.m.—Mr. J. M. Kay and Mr. F. J. Hutchinson: "The Pressurized Water Reactor as a Source of Heat for Steam Power Plants".

INSTITUTE OF PETROLEUM (at 26 Portland Place, London, W.1), at 5.30 p.m.—Mr. G. W. Sears: "Statistics as an Aid to Specification".

BRITISH INSTITUTION OF RADIO ENGINEERS, LONDON SECTION (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 6.30 p.m.—Mr. G. J. Dixon and Mr. H. H. Thomas: "The Remote Presentation of Radar Information".

INSTITUTE OF METAL FINISHING, ORGANIC FINISHING GEOUP (joint meeting with the CORROSION GROUP OF THE SOCIETY OF CHEMICAL INDUSTRY, at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Mr. H. G. Cole: "Chromate Pigments for Metal Protection".

SOCIETY OF CHEMICAL INDUSTRY, CORROSION GROUP (joint meeting with the ORGANIC FINISHING GROUP of the INSTITUTE OF METAL FINISHING, at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Mr. H. G. Cole: "Chromate Pigments for Metal Protection".

SOCIETY OF CHEMICAL INDUSTRY, FOOD GROUP—NUTRITION PANEL (at the Linnean Society of London, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Second meeting in the new series "Nutrition Requirements and Food Fortification".

BRITISH PSYCHOLOGICAL SOCIETY, MEDICAL SECTION (at the Royal Society of Medicine, 1 Wimpole Street, London, W.1), at 8.30 p.m.—Mr. James Laver: "The Psychology of Fashion".

Thursday, December 15

SOCIETY OF CHEMICAL INDUSTRY, ROAD AND BUILDING MATERIALS GROUP (in the Lecture Hall of the Junior Institution of Engineers, Pepys House, 14 Rochester Row, London, S.W.1), at 2.30 p.m. and 6 p.m.—Special meeting on "New and Revised Test Methods".

INSTITUTION OF MINING AND METALLURGY (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

LONDON MATHEMATICAL SOCIETY (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. J. C. Shepherdson: "The Factorisation of Polynomials in a Finite Number of Steps".

INSTITUTION OF CIVIL ENGINEERS (at Great George Street, Westminster, London, S.W.1), at 5.30 p.m.—Sir Richard Southwell, F.R.S.: "MacQuorn Rankine and his Work".

INSTITUTION OF ELECTRICAL ENGINEERS, UTILIZATION SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Dr. A. Nemet and Mr. W. F. Cox: "Intensification of the X-Ray Image in Industrial Radiology".

UNIVERSITY OF LONDON, BRITISH POSTGRADUATE MEDICAL FEDERATION (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.30 p.m.—Dr. R. E. Davies: "Biochemical Aspects of Gastric Secretion". (Last of fifteen lectures on "The Scientific Basis of Medicine".)*

INSTITUTION OF MECHANICAL ENGINEERS, HYDRAULICS GROUP (at 1 Birdcage Walk, Westminster, London, S.W.1), at 6.45 p.m.—Discussion on "Filtration of Liquids".

OIL AND COLOUR CHEMISTS' ASSOCIATION (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1), at 7 p.m.—Mr. R. R. Coupe and Mr. A. H. Smith: "Penetration of Ink into Paper and its Relevance to Print Quality".

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Scientific Papers.

Friday, December 16

BIOCHEMICAL SOCIETY (at St. Thomas's Hospital Medical School, London, S.E.1), at 2 p.m.—Scientific Papers.

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.15 p.m.—Geophysical Discussion—"World-wide Circulation and Exchange of Water". Chairman: Dr. G. E. R. Deacon, F.R.S. Speakers: Dr. W. H. Munk, Dr. D. W. Privett, Dr. R. C. Sutcliffe and Mrs. M. Morgan.

INSTITUTION OF MECHANICAL ENGINEERS (at 1 Birdcage Walk, Westminster, London, S.W.1), at 5.30 p.m.—Dr. E. A. Watson: "Fuel Control and Burning in Aero-gas-turbine Engines" (James Clayton Lecture).

ROYAL AERONAUTICAL SOCIETY (at 4 Hamilton Place London, W.1), at 7 p.m.—Lord Ventry: "Airships of To-day".

Friday, December 16—Saturday, December 17

UNIVERSITIES OF GREAT BRITAIN AND NORTHERN IRELAND (in the William Beveridge Hall, University of London Senate House, London, W.C.1)—Home Universities Conference, 1955.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

DEMONSTRATORS IN THE DEPARTMENT OF PHYSICS—The Registrar, King's College, Newcastle-upon-Tyne (December 15).

CHEMIST or PHYSICIST (with a good honours degree in chemistry or physics, and with industrial or commercial experience), to lead a team involved in overseas sales of special atomic energy materials and equipment (Ref. 1,191); INDUSTRIAL CHEMIST (with a good honours degree in chemistry or chemical engineering or equivalent qualifications, and several years industrial experience on chemical production, and capable of making critical assessments of essential items of process technology) IN THE COMMERCIAL SECTION (Ref. 1,192); and a CHEMIST ENGINEER (with a good honours degree in chemistry or chemical engineering, and with industrial or research experience), to assist in negotiating for the production and sale of atomic energy materials and equipment (Ref. 1,193)—The Recruitment Officer, United Kingdom Atomic Energy Authority, Industrial Group Headquarters, Risley, near Warrington, quoting appropriate Ref. No. (December 16).

PHYSICISTS (with a university degree or equivalent qualification in physics) in the Central Electricity Authorities' Research Laboratories, Leatherhead, for duties which include research on problems associated with the generation and transmission of electricity—The Director of Establishments, Central Electricity Authority, Winsley Street, London, W.1, quoting NAT/702 (December 16).

CHEMIST (with a good honours degree or equivalent qualification) for analytical investigational work at the National Coal Board's Coal Survey Laboratory in Chester—Staff Department (Personnel), National Coal Board, Hobart House, Grosvenor Place, London, S.W.1, quoting SS/121 (December 17).

RESEARCH ASSISTANT (medically qualified) IN CLINICAL MEDICINE—The Registrar, The University, Leeds 2 (December 17).

SENIOR ASSISTANT PHYSICIST (with an honours degree in physics and previous experience in hospital physics)—The Personnel Officer, St. Thomas's Hospital, London, S.E.1 (December 17).

LECTURER (with specialist qualifications in hydraulics) IN THE DEPARTMENT OF FLUID MECHANICS—The Registrar, The University, Liverpool (December 19).

ASSISTANT ZOOLOGIST (with an honours degree in zoology or specialized in entomology or plant nematology) for work in connexion with the beet eelworm and related species of cyst-forming nematodes—The Secretary, School of Agriculture, The University, Cambridge (December 20).

LECTURER IN THE DEPARTMENT OF BACTERIOLOGY—The Secretary, The University, Edinburgh (December 21).

PROFESSOR (with high academic qualifications in the field of mathematics and teaching experience of pure and applied mathematics) OF MATHEMATICS, at the Royal Naval College, Greenwich, London, S.E.10—The Secretary, Civil Service Commission, Burlington Gardens, London, W.1, quoting 4527/55 (December 22).

ELECTRICAL or MECHANICAL ENGINEER (with a first- or second-class honours degree or equivalent qualification in engineering) at a Ministry of Supply Armament Research and Development Establishment, near Sevenoaks, Kent, to conduct a basic development programme in mechanical and electromechanical devices for projectiles and rockets—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting D.548/5A/CA (December 23).

LECTURER IN PSYCHOLOGY at the University of New England, Armidale, New South Wales, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, December 30).

GEOLOGISTS or SENIOR GEOLOGISTS (4) (with a first- or second-class honours degree in geology or equivalent qualification, or high professional attainments) IN THE ATOMIC ENERGY DIVISION of the Geological Survey and Museum, London, S.W.7—Civil Service Commission, Scientific Branch, 30 Old Burlington Street, London, W.1, quoting S.168/169/56 (January 4).

LECTURER in either CIVIL ENGINEERING or MECHANICAL ENGINEERING—The Registrar, University College, Singleton Park, Swansea (January 4).

SENIOR RESEARCH OFFICER or RESEARCH OFFICER (with a university honours degree in engineering, physics, textile science or equivalent qualifications, with additional research experience, not necessarily in textiles) IN THE PHYSICS AND ENGINEERING UNIT, Wool Textile Research Laboratory, Commonwealth Scientific and Industrial Research Organization, Sydney, N.S.W., Australia, to undertake research into the mechanical properties of assemblies of fibres with particular reference to the physical basis of chemical treatments to improve crease retention, dimensional stability and shrink resistance of wool products—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2 (January 6).

ASSISTANT EDUCATIONAL PSYCHOLOGIST—The Director of Education, Shire Hall, Durham (January 7).

CHAIR OF ORGANIC CHEMISTRY at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, January 14).

LECTURER IN PHYSICS at Kumasi College of Technology, Gold Coast—The Secretary, Advisory Committee on Colonial Colleges, 1 Gordon Square, London, W.C.1 (January 16).

READER IN BOTANY at Bedford College, Regent's Park, London, N.W.1—The Academic Registrar, University of London, Senate House, London, W.C.1 (January 25).

READER IN ORGANIC CHEMISTRY, and a READER IN PHYSICAL CHEMISTRY, at King's College, Strand, London, W.C.2—The Academic Registrar, University of London, Senate House, London, W.C.1 (January 30).

SENIOR LECTURER and a LECTURER IN VETERINARY PATHOLOGY—The Secretary of University Court, The University, Glasgow (January 31).

LECTURER (honours graduate in physics or chemistry) IN TEXTILE CHEMISTRY—The Registrar, College of Technology, Manchester 1 (February 6).

ASSISTANT CONSERVATORS OF FORESTS (with a university degree in forestry) in Trinidad—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting BCD.61/38/01.

BIOCHEMIST (preferably with not less than two years post-graduate research experience either in carbohydrate or protein biochemistry or in endocrinology) to work in the Physiology Department on mammary gland metabolism—The Secretary, National Institute for Research in Dairying, Shinfield, Reading, quoting 55/22.

CHEMIST (with at least a second-class honours degree in chemistry, or the A.R.I.C.), in H.M. Oversea Civil Service, Antigua, Leeward Islands, to provide chemical control and advice for the industrial and agricultural development of Antigua—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting BCD.63/34/03.

CHEMISTRY MASTER (with an honours degree in chemistry and experience of teaching at G.C.E. or equivalent level), for G.C.E. courses, under the Iraqi Ministry of Education, Baghdad, Iraq—Dr. A. H. Hilli, Cultural Attaché, Iraqi Embassy, 22 Queen's Gate, London, S.W.7.

GEOLOGISTS (with a university degree in geology), in the Department of Mines, Tasmania, to undertake geological work throughout the State, including investigating and reporting on mines and prospects, general geological work and mapping of areas, advice on water supply, selection of bore sites, and other engineering problems—Agent General for Tasmania, 457 Strand, London, W.C.2.

LECTURER (with an honours degree in metallurgy and preferably with industrial and research experience) IN METALLURGY—The Secretary, Sir John Cass College, Jewry Street, London, E.C.3.

MICROANALYST (Chief)—Prof. E. A. Brande, Organic Chemistry Laboratories, Imperial College, London, S.W.7.

OPERATIONAL RESEARCH OFFICER (with a good university degree in mathematics, science, engineering or economics, and previous operational research experience), to join a team engaged in the study and development of factors affecting productive efficiency throughout the Corporation—Head Office Personnel Officer, British European Airways, Keyline House, Ruislip, Mddx.

PHYSICIST or ELECTRICAL ENGINEER (with at least H.S.C. (science) or equivalent, and experience of electronic equipment) at a Ministry of Supply Armament Research and Development Establishment near Sevenoaks, Kent, for experimental design and development of electronic parts of fuses for projectiles and rockets and associated test and trials equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting D.538/5A/CH.

RESEARCH ASSISTANT (with H.N.C. or equivalent qualification, and previous experience of chemical analysis) IN THE CHEMISTRY DEPARTMENT, to carry out laboratory experiments connected with the physical chemistry of solid steel—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, quoting C.P.2.

SENIOR EXPERIMENTAL OFFICER (with H.S.C. with mathematics or a science subject as principal subject or equivalent qualifications, and an aptitude for analysis of technical information and in particular numerical data), to supervise a technical office concerned with collection, correlation and presentation of works' performance data; presentation of Group programmes; preparation of Group stock accounts for special materials, and building up of basic operational data—The Recruitment Officer, United Kingdom Atomic Energy Authority, Industrial Group Headquarters, Risley, near Warrington, quoting 1,196.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

British Electrical and Allied Industries Research Association. Technical Report L/T 287: Electrode Processes in Spark Discharges. By R. Craig. Pp. 12+11 figures. 12*s.* 6*d.* Technical Report L/T 322: Plasma Oscillations and Energy Loss of Charged Particles in Solids. By H. Frohlich and H. Pelzer. Pp. 5. 3*s.* (Leatherhead: British Electrical and Allied Industries Research Association, 1953 and 1955.) [310

Thermodynamic Properties of Fluids and Other Data (British Thermal Units). Arranged by Y. R. Mayhew and G. F. C. Rogers. Pp. 16. (Oxford: Basil Blackwell.) 2*s.* 6*d.* [310

Proceedings of the University of Durham Philosophical Society, Vol. 12, No. 6: The Venation of the Homopterous Tegmen. By G. Heslop-Harrison. Pp. 42–62. Vol. 12, No. 7: Notes on Morphological Changes Associated With Sexual Maturity in the Male Starry Ray, *Raja Radiata*, Donovan. By Dr. John Phillipson. Pp. 63–72. Vol. 12, No. 8: The Evolution of Mitosis. By Jack L. Crosby. Pp. 73–81. (Durham: University of Durham Philosophical Society, 1955.) [310

Ministry of Agriculture, Fisheries and Food. Domestic Food Consumption and Expenditure, 1953: Annual Report of the National Food Survey Committee. Pp. 104. (London: H.M. Stationery Office, 1955.) 4*s.* net. [310

Avonmouth Works of Imperial Smelting Corporation Limited. Pp. 7+5 plates. (London: Imperial Smelting Corporation, 1955.) [310

North of Scotland College of Agriculture. Calendar, 1955–56. Pp. 252. (Aberdeen: North of Scotland College of Agriculture, 1955.)

Sheffield Metallurgical Association. Report for 1954 and List of Members. Pp. 33. (Sheffield: Sheffield Metallurgical Association, 1955.) [310

Institution of Metallurgists. The Inspection and Testing of Metals: Lectures delivered at the Institution's Refresher Course, 1954. Pp. 120. (London: Institution of Metallurgists, 1955.) 15*s.* 6*d.* [310

Building Research Station Digest. No. 80. (August, 1955): The Prediction of Levels of Daylighting in Buildings. Pp. 8. (London: H.M. Stationery Office, 1955.) 3*d.* net. [310

Other Countries

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Museum at Work: Bernice P. Bishop Museum Annual Report for 1954. Pp. 55. (Honolulu: Bernice P. Bishop Museum, 1955.) [310

Commonwealth of Australia: Department of External Affairs. Australian National Antarctic Research Expeditions. Reports, Series B, Vol. 2—Botany. The Flora, Vegetation and Soils of Macquarie Island. By B. W. Taylor. Pp. ii+192. (Melbourne: Department of External Affairs (Antarctic Division), 1955.) [310

National Academy of Sciences. National Research Council. Eighth Annual Report, Pacific Science Board, 1954. Pp. 61. (Washington, D.C.: National Academy of Sciences—National Research Council, 1955.) [310

State of Illinois: Department of Registration and Education. Natural History Survey Division. Bulletin Vol. 26, Article 3: Natural Availability of Oak Wilt Inocula. By E. A. Curl. Pp. iv+277+324. Vol. 26, Article 4: Efficiency and Selectivity of Commercial Fishing Devices used on the Mississippi River. By William C. Starrett and Paul G. Barnickol. Pp. iv+325–366. (Urbana, Ill.: Department of Registration and Education, Natural History Survey Division, 1955.) [310

Bulletins de la Société Royale de Zoologue d' Anvers. No. 1: Les Infections a Plasmodium chez les Pingouins. Par Dr. J. Rodhain. Pp. 24. No. 2: Les Poissons d'Aquarium du Congo Belge. Par Dr. Max Poll. Pp. 46. No. 3: Les Facteurs Physio-Pathologiques Influencant l'Acclimatation de l'Okapi. Par Dr. L. M. G. Geurden. Apercu Succint de nos Connaissances Actuelles au Sujet de l'Okapi. Par Dr. Vandermander. l'Acclimatation des Okapis a Londres et Copenhague. Extraits de Rapports de MM. C. S. Webb (Curator of Mammals and Birds, Zoological Society of London) et Axel Reventlow (Adm. Director Zool., Have, Kobenhavn). Pp. 54. Nr. 4: Pathology of Birds in Zoological Gardens, with special reference to Salmonellosis. By Prof. L. M. G. Geurden. Pp. 11. No. 5: Quelques Nématodes de la Collection d' Helminthes Récoltés à la Société Royale de Zoologie d'Anvers. Par. Cl. Vuysteke. Pp. 27. (Anvers: Société Royale de Zoologie d'Anvers, 1953 and 1954.) [310

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